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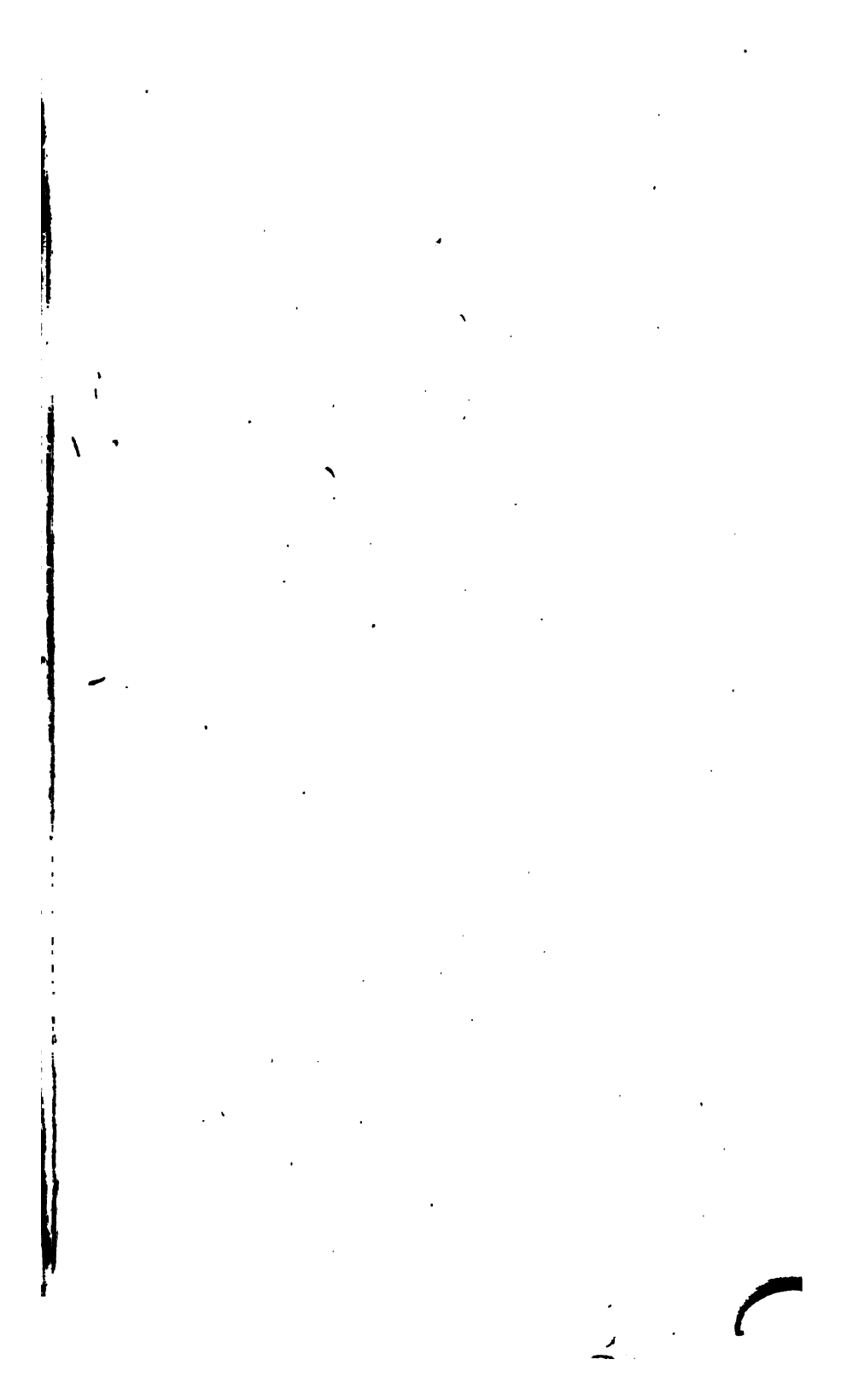
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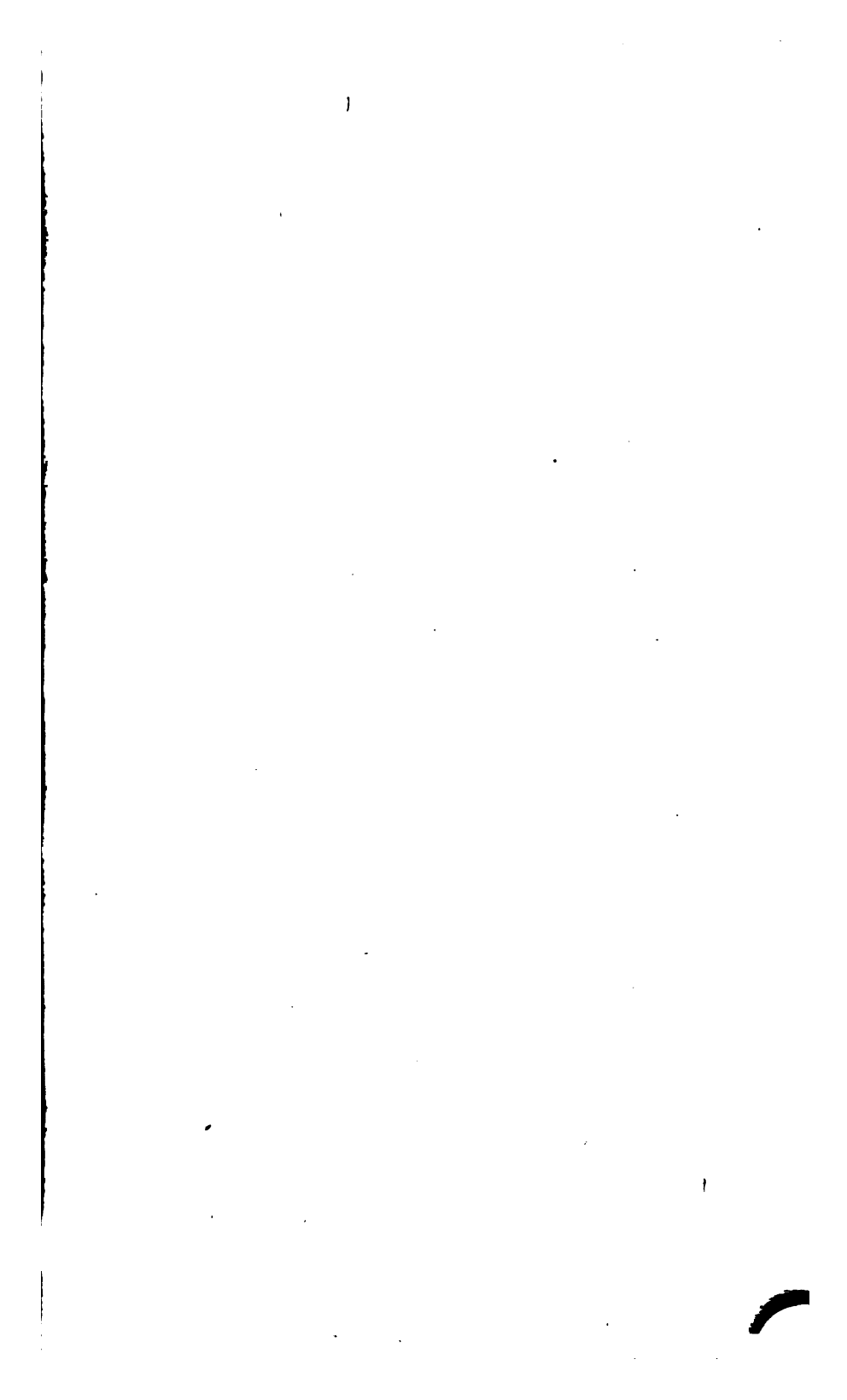








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WESTERN

GEOLOGICAL

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BULLETIN NO. 6.

*Lennonville, Mount Magnet,
and Boogardie,*
MURCHISON GOLDFIELD,

BY

CHAS. G. GIBSON, B.E.,

Assistant Geologist.

*Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.*

WITH A MAP.



PERTH:

BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.

1903.

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Ferruginous Conglomerate at Coates Siding; Geological Features and Mineral Resources of Northampton; Country between Northampton and Peak Hill; Geology of the Peak Hill Goldfield; Horseshoe Diggings; Artesian Water; Fumes from Fremantle Smelting Works; Native Tellurides of Gold; Mineralogical and Petrological Notes; So-called Deep Lead at Kanowna; The 25-Mile Cement Leases; Coolgardie Goldfield. (*Out of print.*)

1903.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 8.

*Lennonville, Mount Magnet,
and Boogardie,*
MURCHISON GOLDFIELD,

BY

CHAS. G. GIBSON, B.E.,

Assistant Geologist.

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WITH A MAP.



PERTH:

✓ AUTHORITY WM. ALFRED WATSON, GOVERNMENT PRINTER.

1903.



PREFATORY NOTE.

DURING the year 1902, a short visit was paid by myself to Lennonville with the object of investigating its mineral resources. It was found that the auriferous deposits were of two distinct types, viz., white quartz reefs, and laminated quartz and jasper veins, approaching very closely the hematite-bearing quartzites which form such a conspicuous feature in some portions of the Murchison and elsewhere in the goldfields of the State.

The two types of deposit bidding fair to become of economic importance, it seemed that assistance could be rendered to private enterprise in the direction of mapping and otherwise investigating these formations in the hope of furnishing a reliable guide for the conduct of the operations of the prospector and the mining engineer. A map embodying the results of the work at Lennonville was issued to the public in the month of September last. It was deemed desirable that the extension of these deposits in the direction of Mount Magnet and Boogardie should be mapped and reported upon. This work was intrusted to the Assistant Geologist, Mr. Gibson. The area embraced by his labours extended over about 36 square miles. Upon the map by which the report is accompanied, all shafts, alluvial workings, existing leases, the strike and underlie of the reefs and ore bodies, in addition to the geological boundaries so far as they can be followed, have been shown, thus rendering the map of general utility.

The main auriferous series of Lennonville, Mount Magnet, and Boogardie is enclosed in a belt of more or less highly altered rocks, for which the term greenstone has been provisionally adopted. Under this head are included diorite, diabase, pyroxenite, together with hornblende and chlorite schist, which may merely represent the crushed or plated out variety of the former, induced by shearing, and possibly modified by chemical action. The greenstones are traversed by belts of laminated quartzites, which rise up from the surrounding country in the form of low, often serrated, ridges. These quartzites are intersected by numerous faults, the mapping of which is of considerable importance from a mining point of view, in that it is along these lines that the rich chutes of gold, for which the district is noted, occur. The bulk of the gold has been found to occur in chutes where the faults intersect the quartzites. Wherever visible, these faults cross the strike of the

quartzites approximately at right angles, and as the latter are generally only from 30 to 60 feet in width, it necessarily follows that the width of the chutes is small. The quartz reefs occur plentifully in both the granite and the greenstone area, though, as a rule, it is only in those occurring in the latter which have proved to be auriferous to any extent. The quartz reefs often form the continuation of the fault lines by which the laminated quartzites are crossed.

It is highly desirable, in the interests of the State, in view of the light conferred by the recent work in the Mount Magnet district, that when opportunity offers the northern extension of this auriferous belt should be geologically examined with the view of showing its relation to the deposits of Nannine, Meekatharra, and other localities in the North Murchison district.

The report and accompanying maps, on being submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

A. GIBB MATTLAND,

Government Geologist.

Geological Survey Office,

Perth, 6th June, 1903.



Lennonville, Mount Magnet, and Boogardie.

Murchison Goldfield.

The Murchison Goldfield, as originally constituted, was first proclaimed on 24th September, 1891. Its boundaries were modified on 15th February, 1895, so as to embrace an area of about 21,000 square miles. As defined by the authorities, the goldfield at present is:—

“Bounded by lines starting from the summit of Mount Murchison and extending north-eastward to the summit of Mount Hale; thence east-south-eastward to the summit of Mount Russell; thence south-westward to the north-west corner of the Yilgarn Goldfield; thence west-north-westward to the summit of Wyemando Hill, and onwards to the trig. station K. 6 on Goonamondey Peak; thence north-westward to the summit of Mount Farmer; and onwards to the summit of Mount Luke, and onwards to the summit of Mount Murchison.”

Extent of the Map.—The map of Lennonville embraces a tract of country extending about one and a-half miles north, three and a-half miles south, two and a-half miles west, and one mile east from the Lennonville Post Office; that of Mount Magnet-Boogardie, a tract extending about two and three-quarter miles north (coterminous with the Lennonville map), two and three-quarter miles south, four miles west, and two and a-half miles east from the Mount Magnet Post Office. On these maps are indicated all shafts, alluvial workings, the positions of existing leases, the strike and underlie of all reefs and ore bodies, and, in addition, all geological boundaries so far as they can be followed. These latter are, in places, only approximate, owing to their being hidden by considerable areas of recent superficial deposits derived from the residual weathering of the older rocks. The thickness of the cover of superficial deposits varies from a few inches up to a maximum of about 20ft. Its extent is not shown on the maps owing to the fact that its boundaries are very ill-defined, and also that in most cases its thickness does not exceed a few inches, thus rendering it not worthy of consideration.

History of the Field.—Very little has been written about the early history of the Murchison Goldfield; the following brief account, however, has been taken from Kimberley's "History of Western Australia," published by subscription in the year 1897:—

"The first place at which gold was discovered on the Murchison was at Yuin—a place long since abandoned—but the first find of any real importance took place at Nannine. . . . The field was first proclaimed in 1891. . . . In 1893 the gold returns of the Murchison fell short of those of 1892 owing to the fact that a large number of miners were leaving for the Coolgardie field. . . . Quartz claims were opened up at several places, a long distance apart, on the Murchison, and a number of gold mining companies were floated. Alluvial still yielded the largest percentage of the output, and rich finds were made at Mount Magnet, Austin's Lake, Nannine, and Cue. The two chief centres at this time were Nannine and Cue. The former township was laid out, declared and excepted from occupation for mining purposes on 20th April, 1893, and the latter on 10th August of the same year. E. P. Dowley became Warden, the Warden's office was removed from Nannine to Cue, and the goldfield was proclaimed a magisterial district. Crushing operations were begun this year (1893); stampers were erected on the Star of the East, near Nannine, and also at Mount Magnet and Cue. Good supplies of fresh water for battery purposes were obtained at various places on the field, notably at the Star of the East, the Day Dawn (Cue), and the New Chum (Mount Magnet). The Government sank wells at Day Dawn, Cue, and on the road from Nannine to Abbots. In each case good water was secured. Eighty-one gold mining leases were applied for on the Murchison in 1893, and 40 business licenses were issued. In January, 1893, the Government offered a bonus to any company or person who would sink a shaft below a depth of 100 feet in any proclaimed goldfield; £2 10s. per foot from 100 to 200 feet, and £5 per foot below 200 feet. During the year the sum of £1,734 was paid to 11 claimants—six at Yilgarn, one at Coolgardie (Bayleys, 180 feet), and four on the Murchison. The Blackbourne (267 feet), had the deepest shaft on the Yilgarn field, and the Black Iguana (174 feet) the deepest on the Murchison.

"Developments on the fields in 1894 far exceeded those of 1893. No phenomenal finds were made as on the Eastern Fields, but a considerable amount of machinery was erected on the mines. A Warden's Court was opened at Yalgoo in August, and the Court at Lake Austin was closed. The average of the stone crushed was very encouraging, and the alluvial also yielded some fair returns in 1894. The total output for the field was 52,946·30ozs., valued at £201,196.

"In 1895 the Murchison Goldfield became so active that the southern portion was separated from the northern, and called the Yalgoo Field. The mining population of this district was about 750. There were 17 batteries at work round Cue, nine round Nannine, and two at Mount Magnet. At Kalgoorlie the best

returns were being obtained, while at Cue and Day Dawn the best machinery was engaged. The towns of Austin and Mount Magnet were proclaimed in 1895, the former on 31st May, the latter on 18th January. The number of miners engaged on the Murchison in 1895 was 2,200."

Previous Observations on the Geology of the Murchison Goldfield.—In his *Mining Handbook** Mr. H. P. Woodward, late Government Geologist, refers the rocks forming the greater portion of Western Australia to the Archean age. According to his account these Archean rocks are usually crystalline, and are found outcropping throughout the State, and being overlaid only in isolated places by much newer formations: these latter rarely of any great thickness. The Archean rocks he divided into three sections, the granites, the gneisses, and the schists, which, as a rule, run in parallel belts north and south, with a slight trend to the north-west. These belts are six in number.

"The fourth, or first auriferous belt, is situated immediately to the eastward of the granite belt, and is about 20 miles in width. It starts from the south coast, at the Phillips River, extending northward in a narrow belt by the Ravensthorpe Range, Parker's Range, Southern Cross, Golden Valley, Mount Jackson, Mount Kenneth, Mount Magnet, Austin's Lake, to Cue; thence it takes a slight bend to the north-east to Nannine and the Star of the East, where it strikes more to the north, and, skirting round the heads of the Murchison and Gascoyne Rivers, it turns north-west and follows down the Ashburton Valley to its junction with the Henry, finally disappearing beneath the palæozoic formations.

"The rocks of this belt consist mostly of hornblende, mica, or talc schists, of which the hornblende schist so closely resembles diorite that it is impossible to distinguish it in a broken specimen. . . . The rocks of this belt are a good deal broken and faulted by granite and diorite dykes and quartz lodes containing gold, iron, and copper. There are also some large magnesia lode masses, rich in fine gold, which will probably prove to be serpentine at a depth. Many of the lodes also contain large quantities of chlorite."

In his report on the Murchison Goldfield,† the same writer says:—"The principal auriferous belt is situated at the eastern side of this area" (i.e., the proclaimed goldfield area), "about 200 miles from the coast; it runs in a north and south direction from West Mount Magnet to Austin's Lake, then in a north-easterly direction to Lake Anneen and Yagahong. Other rich patches and belts exist further east, and a few patches have also been discovered near the coast. . . . The geographical features of the portion of the field on which gold has been discovered are not very

* "*Mining Handbook to the Colony of Western Australia*" by H. P. Woodward, F.G.S., Government Geologist, Perth. By authority: Richard Pether, Government Printer, 1895.

† *Report on the Murchison Goldfield*, by H. P. Woodward, F.G.S., Government Geologist, Perth. By Authority, 1898.

striking, being only the ruined remains of a vast, high, sandy tableland presenting to-day a broken surface consisting of salt marshes or lakes fringed by salt, sand, clay, and gypsum flats, from which rise low rough ridges of metamorphic rocks or white cliffs, on the top of which are sandy plains—the remains of the ancient tableland. There are no well-defined rivers, but the few creeks discharge themselves into the salt flats, where the water evaporates, except after very heavy rains, when they overflow into the rivers which run towards the coast. The hills are mostly small and low, consisting for the most part of ridges of hard metamorphic rocks, near which the rich finds of gold have been made. These are often capped by the same horizontally bedded formation exposed in the cliffs on the edges of the broken tablelands, which are generally covered by dense thickets of low scrub.

“The metamorphic rocks outcrop, rising as low ridges, wherever the overlying desert sandstone tableland has been removed; they are mostly hard large quartz reefs, often forming the axes of the ridges, but more generally beds of highly altered ferruginous quartzite, nearly approaching a mineral vein in character, at their intersection with which the quartz reefs are always the richest.

“Along the principal belt of auriferous country, the rocks for the most part strike a little to the west of north, and underlie to the westward, consisting largely of talcose and granitic rocks, although hornblendic and micaceous slates are also met with. Where there are patches of limestone, the surface is covered by travertine deposits, and the veins are mostly of a ferruginous calcite, in some of which gold has also been found.

“The rocks at the north end of the field take a sudden turn to the north-east and east. Dykes are met with in many places; these are generally either granite or diorite, the latter being of great variety, while the former generally contain crystals of foliated talc in cavities.

“The mineral veins consist mostly of quartz, but ferruginous lodes and veins of calcite and dolomite also exist. The quartz is of great variety, from pure white with talc in the white granite country, to white, blue, and highly mineralised in other places; whilst the calcites and dolomites are mostly ferruginous.

“Where the reefs have been opened up to water level, many of them contain galena as well as iron pyrites, and the veins seem for the most part, as far as one can judge at present, to be true fissure veins, most of them probably continuing in depth; but they will vary greatly in size, direction, and thickness, and many will have to be traced by a mere line or face for a considerable distance.

“The veins rarely follow the strike or dip of the other rocks, but cut across them in all directions; and when they are lost at the ends they generally seem to turn and strike along the line of bedding of the rocks as a mere thread for sometimes a considerable distance, making again into a large body of stone, when they strike off again more or less on their old course. The reefs are found to

be very rich in chutes, the gold being mostly met with at the intersection of certain beds, whilst at other places either large bodies of stone or pinches are accountable to the same cause. The question as to which are the true veins cannot be decided until a more systematic survey of the field has been made; but in most cases where there is a large main line of reef parallel lines are met with which it is quite impossible to trace for any distance; these latter are in all probability not true veins, but only infilled lateral fissures, which, although often very rich, will not extend for any distance either along the surface or in depth.

"The main lines of reef seem to follow a more or less north and south course, but there are some very rich ones which strike east and west; these also vary greatly, some being small cross-courses, extremely rich at their intersection with the main north and south reefs."

Continuing, the same writer says:—"The Mount Magnet diggings are situated a few miles to the south and west of West Mount Magnet, which hill is principally composed of metamorphic rocks, capped by a flat top of desert sandstone.

"The rocks strike mostly a little west of north, and dip to the westward. They are slate, dolomite, talcose schist, and ferruginous jaspery quartzite, all of which are very decomposed.

"The reefs follow much the same strike as the rocks, and dip also to the westward. They are small but well defined, and in some places appear to carry gold pretty well through the stone. The quartz is mostly white, and rather greasy, with ferruginous stains and yellow clay partings; but nothing very rich has been found in the reefing line on this part of the field, except the Monarch Mullocky Leader, which is not a true reef, but a mass of decomposed talcose schists, through which there are a number of small ferruginous quartz veins. The whole mass carries fine gold, but up to the present only the soft part has been worked, and has proved very rich in gold. On the surface here a small but very rich patch of alluvium was worked along the side of a large ferruginous quartzite bar.

"All the alluvial work here has been surfacing, the patches being worked by dryblowing places where a mixture of quartz and ironstone are found scattered over the surface.

"A good deal of gold will probably be found around here, but most of the men are away on the rich finds further north."

Geology of the Field.—The following is a description, based on personal observation, of the geological and cognate features of that portion of the Murchison Goldfield embraced within the boundaries of the accompanying maps.

GENERAL TOPOGRAPHY.—Taking West Mount Magnet as a starting point, the country from east through south to south-west consists of a level plain covered with a shallow deposit of recent beds,

the plain being sparsely timbered with stunted mulga. This plain, which extends south and south-east for 20 or 30 miles, is bounded on the east at a distance of some two or three miles south-east from Mount Magnet by a ridge of granite hills, which, at a point about due east of the mount, merges into a tableland which runs northerly for a distance of some six miles, when it turns away easterly and continues on this bearing for some miles. This tableland is covered with a shallow deposit of sandy soil, derived from the denudation *in situ* of the granitic rocks of which it is composed. It presents on its western and northern edge a more or less vertical cliff face of some 40 or 50 feet (which may mark a line of fault), rising abruptly out of the surrounding plain.

About six miles south-west from Mount Magnet is a low ridge of rough quartzite hills, rising some hundred feet above the surrounding flats and trending from south-west to west some three or four miles, at which point it joins the range of hills coming in from the west of Boogardie.

The country to the north is more broken than to the south, and consists of a series of low, rough quartzite ridges, running slightly west of north, and of isolated greenstone hills, which latter often rise to a height of 150 feet, and are generally capped by a considerable thickness of ironstone conglomerate; they are often flat topped with vertical faces for some 20 feet from the top. The country between these hills and ridges consists of flats covered with red soil derived from the weathering of the older greenstone rocks.

To the west of the Mount, and in the neighbourhood of Boogardie, the country is rough and hilly, consisting of numerous quartzite ridges running for the most part in a general north-westerly direction. These ridges attain their greatest elevation some two or three miles west of Boogardie, where they rise to a height of 150 to 200 feet.

West Mount Magnet itself, the highest point in the district, is a rough round-topped hill 250 feet high, forming the south-western end of a long quartzite ridge.

GENERAL GEOLOGICAL FEATURES.—A belt of more or less highly altered greenstones comprises the main auriferous series which extends in a general northerly direction from West Mount Magnet, past Moyagee, as far north as Lake Austin and the town of Cue. This belt, at a point two or three miles south from Mount Magnet townsite, attains a maximum width of some 15 miles, narrowing rapidly as it runs north, till at a point about half-way between Mount Magnet and Lennonville it is only some five miles across. From this point it widens again to 10 or 12 miles, and continues northerly at this width beyond the limits of the map.

This belt of rocks, to which the general term of "greenstone" has been given, comprises diorite, pyroxenite, altered pyroxenite, together with hornblende and chlorite schists. Owing to the paucity of natural sections, it has been found impossible to distinguish on the

map the relative area occupied by each, and mining operations have not been carried sufficiently far to afford much assistance in this direction.

The rocks naturally vary considerably both in colour and texture, the diorites being the more coarse grained. These are found principally at the southern end of the field, while the rocks at the northern end consist mainly of pyroxenites, a section of which (G.S.M. 3963), seen under the microscope, shows it to consist entirely of a colourless to pale-brown augite, passing in places into a pale green fibrous hornblende. Both the diorite and the pyroxenite occur only over small areas, the greater mass consisting of a considerably foliated rock which appears to be a highly altered form of the latter.

These greenstones are intersected by numerous faults, and they are also traversed by belts of banded quartzites, which rise up from the surrounding country in the form of low, rough ridges, having a general north to north-west trend. These quartzites are especially abundant in the neighbourhood of Boogardie and along the western boundary of the greenstones occurring to the south from this place; they also occur largely on the extreme south-eastern edge of the greenstone belt. The central portion of the district south from Mount Magnet is very free from them, except at the "Six-mile," where a belt of quartzite, forming a bold outcrop, strikes south-west. All these quartzites, occurring to the south of an east and west line passing through Magnet Hill, are highly impregnated with oxide of iron, and in places are distinctly magnetic. North of this line they are practically non-ferruginous. After extending for about six miles northerly, in the form of low parallel ridges, they die out completely, reappearing again some 15 miles further north, where they are once more of the iron-bearing variety.*

It is within this greenstone belt that the gold-bearing reefs and lodes occur. These vary greatly both in size and in the direction of their strike. The largest and richest lines of reef, however, generally run in north and south directions.

The greenstones are bounded on either side by belts of intrusive granite, intermediate between the two being a narrow belt of highly foliated and contorted hornblende and chlorite schists, which pass imperceptibly into, and appear to be merely a localised alteration of, the former. This belt of schists has an average width of some 20 chains. The junction of the granite with the schists on the western side runs in a comparatively straight line on a general north to north-north-west bearing. It is, however, somewhat uneven, small tongues of granite, approaching aplite in composition, running out from the main body into the schists. The junction line on the eastern side is more irregular, varying from almost east and west, at a point due east from Mount Magnet, to north and south a little further north. It has, however, on the whole a general north and south trend. A long tongue of granite runs out

* These quartzites will be found more fully described under "Reefs and Lodes."

from the main body, at a point some two miles east of Mount Magnet, southerly into the greenstones. This tongue, at the point where it leaves the main body, is about a mile across, and runs south for some five or six miles, gradually dying out below the alluvium of the plains. There are, also, numerous dykes of intrusive granite in the greenstones, especially in the southern end of the district. These dykes are finer in texture than the main granite bodies, and in places approach closely to a felsite in general appearance. The main body of granite is a coarse-grained biotite variety (G.S.M. 3960), a section of it seen under the microscope showing it to consist of quartz, felspar, principally plagioclase, together with a little microcline, biotite, and little magnetite; the biotite being very abundant, and occurring in large tabular crystals. It appears to be undoubtedly of intrusive origin, the greenstones being highly foliated and contorted near their junction with it, the schists usually dipping away from the granite. Patches of greenstone schists are also found caught up in mass of the granite itself. A large mass of undoubtedly intrusive granite occurs near Moyagee; this is some ten miles long and several miles across, and is entirely within the greenstones, which have their usual contorted appearance near the junction.

The greater part of the country to the south and south-west of Mount Magnet is covered by shallow recent accumulations, consisting of red sandy soil, resulting from the gradual denudation of the older greenstone and granitic rocks *in situ*. This deposit is of very limited thickness, and rarely exceeds 15 to 20 feet.

There is another class of recent formations found in the district; these are the ironstone gravel deposits (laterite); they occur only over very small areas, generally as the cappings of hills, and consist of nodules of siliceous limonite and hematite cemented together with ferruginous silica and clay. They are probably formed by the gradual concentration of ferric oxide, resulting from the local decomposition of rocks rich in iron. The majority of them are of poor quality, and their actual iron contents low.

There are, however, two small deposits of this class, which are considerably above the average in their iron contents; they occur in the neighbourhood of Boogardie; one on the east side of the Eclipse Hill and the other on the north-east side of the Havelock Hill, and are very limited in extent, having only an area of a few square chains. An analysis made in the Geological laboratory of a sample of the former of these (G.S.M. 4372), taken from G.M.L. 635m, gave results as follows:—

Metallic iron	...	...	...	51.67	per cent.
Silica	...	...	...	11.46	"
Sulphur	...	...	...	.084	"
Phosphorus...	...	...	...	.023	"
Combined water	...	...	...	2.67	"
Moisture	...	...	...	.19	"

When the ironstone gravels occur as the cappings of hills, they generally have vertical cliff faces for a height of 20 to 30 feet; these faces are broken by numerous small caves, in which an impure

natural bitumen is often found. This bitumen, which is taken by many of the prospectors to be an indication of the presence of mineral oil in the surrounding rocks, is probably, from its mode of occurrence and general appearance, merely a decomposition product of the excrement of wallabies and kangaroos, by which these caves have been largely used.

REEFS AND LODS.

Banded Quartzites. — These are of two varieties, the "hematite bearing" and the "non-hematite bearing." The former is the more prevalent type, and occurs principally in the neighbourhood of Boogardie. They will during the remainder of this report be spoken of as the "Boogardie" type. The "non-hematite bearing," or "Lennonville" type, as they will be called, occur only within the Lennonville district, and in small areas at the Morning Star, Paris, and Hector Hill G.M.Ls. in the Mount Magnet district; they are much more limited in extent than the "Boogardie" type. They occur as low, rough ridges of hard compact black and white, or brown and white, quartz, outcropping in belts, generally from two to four chains in width, and with a vertical dip. On breaking through the hard upper surface of these belts they are found to alter greatly in appearance, changing in a few feet from hard compact quartz to alternating thin bands of hard white to grey quartz and soft kaolin. These quartzites invariably carry gold, but not always in payable quantities; there are, however, in them numerous rich chutes, which are being worked with satisfactory results, the gold being found both in the quartz and the kaolin.

The "Boogardie" quartzites differ from the preceding, in that they are more compact at a depth, and are highly impregnated with oxide of iron, usually hematite, but often also with magnetite as well, when they are naturally highly magnetic and render it utterly impossible to use a compass with any degree of accuracy in their vicinity. They also usually carry a considerable amount of pyrites at a depth.

These quartzites are of two varieties: one in which the quartz and iron oxides are in well-defined alternate thin layers, the iron being the predominating mineral; and the other in which the quartz predominates, and the lamination is not so pronounced, a broken specimen having almost the appearance of a highly ferruginous compact quartz. This latter variety, the so-called "jasper" of the local miners, is especially abundant about Boogardie, where the beds run in a series of north-north-west and south-south-east ridges. They differ from the "Lennonville" quartzites in their mode of occurrence, in that they run in a series of narrow parallel bands from one-half to one chain in width, as many as 12 of these bands outcropping along the top of a single ridge, whereas those of Lennonville run in single wide bands, often five to ten chains across. They further preserve their compactness as far as any depth yet reached; none of the kaolin, which is characteristic of the latter

type, being present. They are traversed by numerous faults, the displacement in almost every case being to the right. It is only along these faults that the rich chutes of gold, for which this district is noted, occur.

The following are three partial analyses of samples of these hematite-bearing quartzites made in the Geological laboratory:—

G.S.M.	4377	4384	4376
Metallic iron ...	50.55 ...	32.83 ...	26.63
Silica ...	24.26 ...	52.50 ...	61.13
Sulphur ...	.029 ...	.017 ...	.019
Phosphorus ...	.042 ...	.072 ...	.028
Combined water ...	2.94 ...	1.33 ...	.66
Moisture ...	.41 ...	.08 ...	.07

The numbers (G.S.M. 4377, etc.) refer to the Geological Survey Museum Register. G.S.M. 4376 is a sample taken from the top of West Mount Magnet; G.S.M. 4384 is from a dump on the Havelock G.M.L.; G.S.M. 4377 is from a spot half a mile north-west from the Trig. Station, K. 5.

The manner in which the gold is found in these two types of quartzites differs considerably. In the Lennonville district the gold is obtained in the main body of the quartzites themselves, generally occurring in chutes, some of which are of considerable extent. In the Boogardie district, on the other hand, the quartzites carry but a very slight trace of gold, and it is only in one or two places at the northern end that they are rich enough to pay for working. The bulk of the gold is obtained in rich chutes, occurring in the faults crossing the quartzite bars. These faults cross the bars almost at right angles, and as the latter are generally only from half to one chain in width, the chutes are of necessity short, as they are never found to continue into the country rock, being invariably restricted to the limits of the quartzite bar. The fissures produced by these faults are invariably filled with brecciated quartzite, cemented together with chalcedonic quartz, and traversed by small irregular quartz veins. It is in this quartz that the majority of the gold occurs. The fissures vary considerably in size, but usually range in width from three to six feet. The walls are sharp and well defined, consisting of hard compact quartzite, and usually, like the main body of the bars, carry only a slight trace of gold. These fault fissures are very numerous round about Boogardie, occurring every few chains along the main lines of quartzites; they invariably carry gold, some being extraordinarily rich in places, whilst others again contain only a trace.

The main bands of quartzites appear to have been old fault lines or joints, along which the original greenstones have been highly foliated parallel to the line of faulting or jointing, and thus formed zones of weakness, along which thermal solutions containing silica, iron, etc., have forced their way to the surface, and gradually converted the original foliated greenstones into their present form. This appears to be borne out by the fact that they almost invariably run with the general strike of the country, viz.,

about north-north-west and south-south-east, and also that in several places they can be seen to tail out and insensibly pass into foliated greenstone.

In his report* on the Island Lake Austin, Mr. Woodward, late Government Geologist, writing of the quartzites in that locality, remarks:—"The banded quartz reefs are the main feature of this district, being met with both at Mount Magnet and Nannine, as well as at the Island. They generally rise above the surface as rough rock ridges, which rarely extend half-a-mile in length; they do not follow one main fissure line, but lie a little to the east or west, as the case may be. At the surface they appear to consist mostly of banded ironstone with jasper veins, but when cut below water line they prove to be banded blue and white quartz, containing considerable quantities of pyrites in places. These lodes, although poor, always contain a small quantity of gold, and invariably exercise considerable influence upon the richness of the quartz reefs of the district, which rarely contain gold except when in proximity to them."

It will be thus seen that these Lake Austin quartzites differ slightly from those of Boogardie which preserve their hard compact ferruginous character as far as tested in depth (about 130ft. below water level).

Quartz Reefs.—Quartz reefs occur plentifully both in the granite and in the greenstones, and are found to vary considerably both in size as well as in the direction of their strike. Generally speaking, it is only the reefs in the greenstones which have proved to be auriferous; they are for the most part small and usually trend a little to the west of north, and the east of south, and can rarely ever be followed for any great distance. There are a few east and west reefs, but these are generally found to be much poorer in their gold contents than those trending north and south. There are several very large white quartz reefs following the junction line of the granite on both sides of the greenstone belt. These, however, as far as tested, have proved to carry no trace of gold. In the auriferous reefs the gold is very often found to occur in chutes, which, although generally short, are frequently very rich.

Associated Minerals.—Pyrites occurs in more or less quantity in most of the quartz reefs throughout the district, and also in considerable quantities in the ferruginous quartzites round Boogardie, being generally found at or below water level. It is almost invariably found to carry gold.

Stibnite is found in small quantities in the ore bodies at the lower levels of the Morning Star G.M., Mount Magnet.

Pyrolusite is also found in small quantities in the lode stuff in the lower levels of the Hesperian G.M., Boogardie.

* The Island Lake Austin. Annual Progress Report of the Geological Survey for the year 1901. Perth: By Authority: 1902, p. 12.

An alloy of gold and mercury is reported to have been met with in the Havelock G.M., Boogardie.

Water.—The field as a whole is well watered, and as a rule abundance of good fresh water can be obtained at a depth of from 80 to 130 feet. There are, however, one or two exceptions, notably the Long Reef G.M. at Lennonville, and the Morning Star G.M. at Mount Magnet, where the supply is somewhat salt. It is, however, suitable for battery practice, for which purpose it is being used on both mines.

Timber.—Timber for mining purposes and for fuel is rapidly becoming a very serious item on the field. There is nothing but mulga in the district, and this has now to be brought in considerable distances, principally by means of camels.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit (November, 1902). There are probably a few mines whose names do not appear on this list; this is because I was at the time unable to examine them owing to the fact that many were either abandoned, under exemption, or otherwise inaccessible.

MT. MAGNET DISTRICT.

MORNING STAR G.M. Ls. 314M, 317M, 320M.—This property, which is at present the most important in the Mt. Magnet district, has its workings down to a vertical depth of about 350 feet. Two lines of reef are being worked. The main one, known as the "Star" lode, consists of a large irregular quartz reef running about north and south; this reef is as much as 12 feet in width, but is not at all uniform either in size or in its gold values. The second lode, known as the "Easter" lode, is some 10 chains to the east of the main reef, and consists of a belt of very broken banded quartzites some 30 feet in thickness and also running north and south. Some very rich stone was obtained from this lode near the surface. The main shaft has been sunk on the "Star" lode to a depth of about 350 feet, and levels and crosscuts put in at 100, 200, 250, and 300 feet, and a large amount of stoping done, principally on this line of reef. A plentiful supply of water was struck at about 110 feet; it is, however, somewhat salt, this being one of the very few mines in the district in which fresh water was not obtained. The total stone crushed to the end of 1902 is 69,968·00 tons for 44,767·96ozs., an average of 64oz. per ton.

IGUANA G.M. L. 457M.—On this lease two vertical shafts have been sunk, about 150ft. apart, on a small north and south quartz reef. A connecting drive has been put in at the 90 ft. level, and the reef stoped out to the surface. The reef is about 12 inches wide at its outcrop, widening to two feet at the bottom of the workings, and dips about 53° to the east. The country is soft decomposed greenstone, and carries a small amount of gold for

about 12 inches on each side of the reef. Water was struck at about 75 feet, the supply being brackish. At present a new vertical shaft is being sunk on the hanging wall side of the reef to cut it at about 200 feet. The average yield for the last two crushings was 1oz. 3dwts. per ton. The total stone crushed from this mine to date is 348·00 tons for 427·20ozs., giving an average of 1·22ozs. per ton.

BRITANNIA G.M.L. 545M.—This property is situated near the "Six Mile," some five miles south-west from Mount Magnet. On it a main shaft has been sunk to a vertical depth of 90 feet on a lode formation, consisting of a soft decomposed schist highly impregnated with quartz. This lode is about 15 feet wide and runs east and west. A drive has been put in for a distance of some hundred feet at the 50-ft. level, and a considerable quantity of stone raised. A good supply of fresh water has been struck at 50 feet, and most of the stone raised is now being put through a horse puddler with satisfactory results. A crushing of 25 tons put through the Boogardie public battery lately gave an average return of about 1½ozs. per ton. A large quartz reef runs north and south through the property near the eastern boundary, dipping about 60° to the west. This reef is some 12 feet wide, and an underlie shaft has been sunk on it to a depth of about 40 feet. No further work has been done on it as the gold contents are low. Crushings to end of 1902, 176 tons for 168·77ozs., giving an average of ·96oz. per ton.

COMET G.M.L. 489.—Several small ferruginous quartzite bars run through this lease in a north-west and south-easterly direction. On one of these a vertical shaft has been sunk to a depth of 60 feet, and on a second a shaft and open cut have been put down some 30 feet. This bar is from two to three feet wide, and dips to the north-east at an angle of about 75°. The gold in these bars is very patchy, but some very rich specimens have been taken out. The total stone crushed to the end of 1902 is 65 tons for 54·47ozs., including 3ozs. dollied; an average of ·83ozs. per ton.

CUSHIE DOO G.M.L. 490.—Three shafts are down on this property, all to a depth of about 65 feet; of these two are vertical and one underlay. A crosscut has been put in at the 65 feet level easterly between the underlay shaft and one of the vertical ones, a distance of about 50 feet, and also westerly for about 30 feet. The country consists of soft kaolinised greenstone, and is traversed by numerous north and south faults. Small bunches of mixed kaolin and quartz occur on the faces of these faults, and carry considerable quantities of gold. It is these bunches that are being principally worked at present, though work is also being done on a fair-sized north and south body of banded quartzites. This, however, is of low grade, and not of much value as far as prospected. The stone crushed from this mine to the end of 1902 was 104 tons for 285·15ozs.; including 87·80ozs. dollied and specimens, giving an average of 2·74ozs. per ton.

PARIS G.M.L. 476.—There is a large banded quartzite lode, similar to the Lennonville quartzites, on this lease, the width of which has been proved to be not less than 60 feet. There are two old shafts on this lode, the most southerly of which is down to a depth of 130 feet. Short east and west drives were put in from this shaft at 30, 60, and 10 feet. It was then abandoned and is now full of water to 105 feet. The stone taken out of this shaft averaged from 4 to 8dwts. per ton. From a second shaft further north on the same lode some 200 tons of stone were taken out between the surface and 50 feet, and crushed for an average yield of 25dwts. of gold per ton. The lode is now being worked from a shaft sunk to a vertical depth of 50 feet on the eastern side near the centre of the lease. The stone from this shaft is expected to average from 4 to 10dwts. per ton. The total stone crushed from this mine to date is 662·00 tons for 370·61ozs., an average of ·56oz. per ton.

MONARCH G.M.L. 523.—This property was abandoned at the time of my visit, but Mr. H. P. Woodward, late Government Geologist, in his report on the Murchison Goldfield, thus describes it:—"On this area a mass of decomposed talcose schist, with small ferruginous quartz leaders, often jaspersy, is being worked. The gold is mostly very fine, but it is plainly visible on the faces of the schistose rocks and all through the quartz, many specimens being extremely rich. There is a large mass of this gold-bearing material, but the full extent is not at present known. The country strikes a little west of north, and dips to the westward at a high angle. . . . A very great deal of gold has been got from this claim by simply puddling and washing the decomposed rock, whilst the stone has been reserved for crushing." . . . Total crushings, 365 tons for 202·15ozs., being an average of ·55oz. per ton.

BOOGARDIE DISTRICT.

BOOMER G.M.L. 522M.—There are three shafts on this property, a main vertical shaft, down 105 feet, and two underlay shafts, 70 feet—all working on a large ferruginous quartzite bar, running about north-west and south-east, and dipping to the north-east at an angle of 75°. This bar is from 30 to 40 feet wide, and on the eastern side is soft, and broken for a thickness of some six feet. This portion carries the best gold, and averages about 8dwts. for the whole width, the richest stone being got on the extreme eastern edge. The remainder of the bar carries but a slight trace of gold. The gold-bearing portion of the lode has been stoped out for about 50 feet at the northern underlay shaft, small patches of it being very rich. The main vertical shaft has been sunk on the hanging wall side of the lode, and a short drive put in to cut the bar at 105ft. The country consists of soft decomposed greenstone. Good water was struck at 105ft. Total stone crushed, 209 tons for 39·87ozs.; an average of ·19oz. per ton.

GOLDEN STREAM G.M.L. 548M.—Four parallel vertical quartzite bars run through this lease in a north-westerly and south-easterly direction. On the most easterly of these, three shafts have been sunk to a depth of 65ft. From the middle one of these two sets of levels have been driven along the eastern side of the bar; the upper, at 50ft., has been driven some 75ft. northerly, while the lower, at 65ft., runs for some 400ft. northerly and about 150ft. southerly. The ore body consists of a mixture of quartz and honey-combed quartzite attached to the eastern side of the quartzite bar. It varies in thickness from a few inches to as much as 4ft. Its gold contents are patchy, ranging from a few dwts. to several ounces, the average being 8dwts. to 10dwts. The quartzite bar itself, as usual, carries only a very small amount of gold. Several lines of fault cross the bars in an east and west direction, and generally throw them to the right; the throw, as a rule, being only a few feet. A small granite dyke runs parallel to the bar some 20ft. to the east. The country is soft decomposed greenstone. A plentiful supply of fresh water was struck at 65ft. The total stone crushed from this lease, to the end of 1902, is 683'50 tons for 355'54ozs., being at the rate of '52oz. per ton.

CALEDONIA G.M.L. 607M.—This property adjoins the Golden Stream on the north, and is on slightly higher ground. A vertical shaft has been sunk to water level (85ft.) on the eastern side of the same quartzite bar as the Golden Stream workings are on, and two drives have been put in some 20 or 30 feet northerly along the bar at 60 and 85 feet. The ore body, which is small, is the same as in the Golden Stream. Crushed 15 tons for 2'35ozs., being at the rate of '16oz. per ton.

HAVELOCK G.M.L.—There are six shafts down on this lease, working on a series of parallel quartzite bars running in a north-westerly and south-easterly direction. The deepest of these is down about 135ft. to water level, the others being all from 100ft. to 110ft. in depth. Altogether three separate bars are being worked; these average from 20ft. to 30ft. in width, and are some 60ft. to 80ft. apart. They carry gold for their full width, having an average value of about 6dwts. Crosscuts have been put in east and west to connect several of the shafts at 100ft., and at this depth levels have also been driven some 100ft. or so along the bars both northerly and southerly. The bars are of the compact ferruginous type common to this district, and as usual are frequently broken by faults, rich chutes of gold being generally obtained at the spots where these breaks occur. Good water was struck at 135ft. The total stone crushed from this lease to date is 1,007 tons for 844'35ozs., including 55ozs. dollied and specimens; giving an average of '83oz. per ton.

HESPERIAN AND LADY BUNBURY G.M.Ls. 361M, 379M.—These two leases are at present being worked in conjunction; a main pumping and hauling shaft has been sunk to a depth of 200ft. on the Lady Bunbury lease, near the northern boundary; a large quantity of water is being pumped out of this shaft, thus draining

both this property and the adjoining one (the Hesperian). On this latter lease a vertical shaft has been sunk to a depth of 100ft. near the southern boundary, for the purpose of working a rich body of ore occurring in a break in a large quartzite bar which runs north-westerly and south-easterly through the middle of the two properties. This ore body is some 30 feet in length (being entirely confined within the limits of the quartzite bar), and varies in thickness from about 12 feet to almost nothing; it consists of brecciated quartzite cemented together with chalcedonic quartz and small quartz veins. It has no well-defined walls, passing in places gradually into the hard compact quartzite of the bar, which, as usual, carries only a slight trace of gold. It dips at an angle of about 80 degrees to the south-east, and at about the 150-foot level passes into the Lady Bunbury lease. From the Hesperian shaft a short drive has been put in at the 100-foot level, and a winze sunk to 150 feet. The whole ore body has then been stoped out to the surface. From the 150-foot level a second winze has been put down another 50 feet, and connected by a short drive with the Lady Bunbury shaft, and stoping is now (November, 1902) being carried up from this level, where the average width of the ore body is from one to two feet. The gold contents of the stone raised vary considerably; some of the richest ore was got from the 150-foot level, where some parcels of stone were got averaging about 30ozs. Samples from the 125-foot level, Hesperian G.M., assayed in the departmental laboratory gave results ranging from 2ozs. to $11\frac{1}{2}$ ozs. per ton. A large number of parallel quartzite bars run through these two properties, and shafts have been sunk on several of them, but without satisfactory results. The country is soft decomposed greenstone, passing into hard settled rock at about 180 feet. Like most of the mines in this district, the water is fresh, and was first met with at 150 feet. The crushings from these two properties to the end of 1902 were as follows:—

—	Stone crushed.	Gold therefrom.	Average oz. per ton.
	tons.	ozs.	
Hesperian ...	1,597·00	2,134·50	1·33
Lady Bunbury ...	512·65	166·84	0·32

ECLIPSE EXTENDED G.M.L. 264M.—On this lease a vertical shaft has been sunk to a depth of about 110 feet on an ore body exactly similar in character and mode of occurrence to that on the Hesperian lease. This ore body extends only the width of the quartzite bar in which it is found, about 30 feet, and varies in thickness from three to 20 feet. It has been stoped out for its full width from 110 feet to the surface, but no further work has been done on it. Total stone crushed, 914·75 tons for 1,830·59ozs., being at the rate of 2·00ozs. per ton.

HESPERUS DAWN G.M.L. 463.—An ore body similar in all respects to the two foregoing has been worked out on this property to a depth of 150 feet (water level). At the time of my visit no work was being done, owing to the property being under exemption. From this lease, 521.98 tons of stone have been crushed for a yield of 1,860.95ozs., being at the rate of 3.56ozs. per ton.

GOLDEN BELLE G.M.L. 648.—There are several small shafts on this property working on small bodies of ore in the breaks of the quartzite bars similar to those worked in the three previous properties. There have been no crushings from this property to date.

JUPITER G.M.L. 190.—Four small quartzite bars run through this lease, in a north-westerly and south-easterly direction. On the most easterly of these a main shaft has been sunk to a depth of 175 feet, and levels driven along the bar at 100 and 175 feet; that at 100 feet has been driven some 100 feet northerly and 200 feet southerly, and that at 175 feet about 50 feet northerly and 170 feet southerly. At present the lower workings are flooded, and the mine full of water to 105 feet. A small party are now working the property on tribute, and are engaged in taking out stone from the 100-foot level. The bar as opened up here is from 4 to 6 feet wide, and carries gold right through in amounts varying from several dwts. to as much as 2ozs. For the most part it consists of hard compact ferruginous quartzite, but some parts are considerably softer and less compact than others. It is in these softer portions that the best gold is found. Several faults cross the bars in an east and west direction, and rich chutes of stone are generally found along the breaks. Below water level the stone carries a large amount of pyrites, which is invariably found to carry gold. Several smaller shafts have been sunk on the main bar, and also on a second small bar further westward, but very little work has been done from them. A small felsite dyke runs across the lease in an east and west direction, about 150 feet south of the main shafts, and cuts through the bars, without, however, displacing them at all. The country to water level consists of soft decomposed greenstone, becoming harder and more settled at about 150 to 180 feet. Salt water was struck at 110 feet, and was very abundant at the lower levels. This is the only mine in the Boogardie district in which salt water has been met with. From this lease 1,630.15 tons of stone have been crushed, for a total yield of 1,252.08ozs., giving an average of .77oz. per ton.

SIEDAR G.M.L. 571.—There are two vertical shafts down on this lease, one, the main working shaft, down 90 feet, and the other 55 feet. The main shaft has been sunk on the west side of a large north-west and south-east quartzite bar, and at 75 feet a crosscut has been driven easterly into the bar for a distance of about 60 feet. The bar for the whole of this distance carries gold, and averages from 6 to 12dwts. No stoping has been done, and no drives put in at the lower level. From the second shaft two crosscuts have been put in, one at the 40 feet level for about 20 feet easterly, and one at the 55 feet for some 45 feet westerly. This latter crosscut

cuts through three small vertical quartzite bars, running north-west and south-east, the first two of which are about three feet wide, and the third almost westerly about 20 feet. These bars have been sampled for their full width, their average gold contents being about 8dwts. per ton. In all 529 tons of stone have been crushed from this mine for a yield of 244·30ozs., being at the rate of 46oz. per ton.

NEPTUNE G.M.L. 445.—The main working shaft on this property has been sunk vertically to a depth of 210 feet on the eastern side of a large quartzite bar running through the middle of the lease in the prevailing north-west and south-east direction. Two drives have been put in south-westerly from it, one at 109 feet and the other at 200 feet, both of which are about 70 feet in length. The ore body consists of quartzite and brecciated quartzite, and is some three or four feet wide; it runs vertically across the main quartzite bar in a south-westerly direction, and is apparently an old fault line along which the quartz has been deposited. The length of the ore body has not yet been proved. The gold contents, as is usual with this class of ore body in this district, vary considerably, ranging from 1oz. to 13ozs., being richest where the quartz is most abundant. The main body of quartzite also carries a considerable amount of gold, but not sufficient to pay for working. The country on each side of the quartzite bar consists of greenstone, very decomposed and softened near the surface, but becoming hard and compact at the 200-foot level. Several small shafts have been put down at different places along the main bar of quartzite, but without result, and have since been abandoned. A good supply of fresh water was struck in the main shaft at about 110 feet. The total crushings to date from this mine are 452 tons for 1,161·15ozs., including 557·76ozs. dollied and specimens, being an average of 2·57ozs. per ton.

MARSHITE G.M.L. 220 (late O.K. North).—On this property a quartz reef running north-east and south-west has been worked by means of three shafts, two vertical and one underlay, down to depths varying from 50 to 80 feet. At present two of these shafts have been abandoned, and the reef is being worked from a main vertical shaft, sunk on it to a depth of 80ft. At this level drives have been put in both ways along the reef for a total distance of about 200 feet, and a winze sunk a further depth of 35 feet to water level. No stopping has been done. The reef consists of white quartz considerably laminated at the northern end, and is about four feet wide. It runs vertically, and has sharp, well-defined walls on both sides, the country being soft, decomposed greenstone. The average gold contents of the reef are about 6dwts. per ton. A fourth shaft has been sunk on a small quartzite bar near the southern boundary of the property, but without any satisfactory results, and it has since been abandoned. The returns from this mine to date are 24 tons of stone crushed for a yield of 5·50ozs., being at the rate of 23oz. per ton.

LENNONVILLE.

GOLDEN GIANT WEST G.M.L. 567.—There is a main vertical shaft down some 150 feet on this lease. It is, however, at present (October, 1902) abandoned, and the only work done on the property is being carried on in a large open cut. The lode, as opened up in this cut, consists of banded quartzite intersected by numerous small quartz leaders. The full width of it has not yet been exposed. Some samples of stone taken from the face of the open cut and dollied, gave very good prospects.

BAXTER'S REWARD G.M.L. 604m.—On this property a main shaft has been sunk vertically to a depth of 135ft. in the centre of a large quartzite bar. At 75ft. a drive has been put in north and south along the strike of the quartzites with the object of working a small quartz reef running in that direction. This reef at the southern end of the drive is about 1ft. in width and about 2ft. 6in. at the northern end and dips at a high angle to the westward. Drives have also been put in both ways along the reef at 95ft. and 135ft. for about the same distance, the reef being of the same size as in the upper level; a crosscut has also been put in Easterly for a distance of some 20ft. at the 135ft. level in order to test the values of the quartzites, which always carry a certain amount of gold.

FAIR PLAY G.M.L. 333m.—On this lease two vertical shafts have been sunk (some 160ft. apart) on a small north and south quartz reef. Of these the main shaft has been sunk to a depth of 200ft. while the second, or more Northerly, is down 130ft. to water level. These shafts are connected at the 130-foot level by a drive which has also been continued some 60ft. south of the main shaft; at the 200-foot level about 90ft. of driving has been done from the main shaft some 70ft. north and 20ft. south; a winze has also been sunk from the 130-foot level to a further depth of 35ft. at a point some 30ft. south of the northern shaft. The reef consists of white quartz and is small, having a maximum thickness of some 10in. to 13in. The country is soft decomposed greenstone.

SIMMER AND JACK G.M.L. 586.—A small vertical North and South quartz reef is being worked on this property; several shafts have been sunk, the main one being down 105ft. vertical, and a fair amount of work done. The reef is very thin as a rule, but at one place there is a thickness of nearly five feet of clean quartz. Another vertical shaft further west is down about 100ft., and a crosscut has been put in Easterly for a distance of some 50ft. at the 40-foot level. The shaft has, however, been since abandoned. The country consists of a slightly decomposed foliated serpentinous rock, the lines of cleavage of which trend north and south, and run vertically.

SPLENDOUR G.M.L. 421m.—A fair sized North and South reef runs through the centre of this lease, dipping at a high angle to the

westward. A vertical shaft has been sunk to a depth of 80ft. on the footwall side, and short crosscuts have been put in to cut the reef at 50ft. and 80ft., and levels driven along it for some distance. The average width of the reef is about two feet six inches, but it is rather irregular, being as much as five feet in width in some places.

TARCOOLA G.M.L. 590M.—There are several shafts down on this property to depths varying from 40 to 70 feet; the main working shaft is down 70ft., on a fair sized quartz reef, trending north-west and south-east and dipping to the westward. This reef is from four to five feet wide, and a considerable amount of work has been done on it, but at present (October, 1902), the workings are inaccessible. Another working shaft, further to the north-east, is down some 70ft. on a small quartz reef, striking north-west and dipping to the westward. The width of this reef is about 18 inches.

GAMBIER 535M.—On this lease a main shaft has been sunk to a depth of 140ft. on the western side of a quartz reef, striking north-west and south-east, and at 60ft. a crosscut has been put in easterly to cut the reef, and a level driven along the line of the reef. This reef is some three feet wide, and is, apparently, the same one as is being worked on the adjoining lease (the Tarcoola). The lower workings on the property were inaccessible.

THE GIANT G.M.L.—This property adjoins the Canterbury on the south. Very little work has been done on it. At present there is a large open cut on a banded quartzite bar. A small quartz reef runs through the deposit in the direction of the strike of the quartzite (north and south). Samples taken from the open cut and dollied showed good prospects. 65·00 tons have been crushed from the lease for a yield of 18·53ozs., being at the rate of 28oz. per ton.

BROOKLYN SOUTH G.M.L. 605.—Here a shaft has been sunk to a depth of about 80ft. on a vertical quartz reef running north and south. A drive has been put in 40ft. along the reef southerly at the 50-foot level, and a little stoping has been done.

UNION JACK G.M.L. 611.—A large banded quartzite bar runs north and south through the centre of this property. On the western side of this bar an underlay shaft has been sunk to a depth of about 30ft. The section in the shaft shows the lode to consist of banded grey and white quartz, with bands of kaolin, rendering the deposit very friable. No further work has been done, and the full width of the deposit is not yet determined. There have been no crushings to date.

GOLDEN HILL G.M.L. 511.—This property is also working on a large north and south body of banded quartzites. The main body of these is some three to four chains across, and runs through the middle of the property. On the western side of this body a shaft has been sunk to a vertical depth of 80ft., and a drive put in northerly for a distance of 35ft. at this level. The ore body is situated on the extreme western edge of the quartzite bar, and is from five to eight feet in width. It consists of a brecciated mass of quartzite cemented together with kaolin, and varies considerably in its gold contents. This property has crushed to the end of 1902 298·50 tons for 85·07ozs., giving an average of ·27oz. per ton.

THE FARM G.M.L., 582.—This property adjoins the Golden Gem on the south; on it a main shaft has been sunk about 50ft., and crosscuts put in north-west and south-east for a total distance of about 200ft., but so far without result. The country consists of very soft decomposed greenstone.

GALTEE MORE G.M.L. 843.—This property is situated some three miles south of Lennonville townsite. A large banded quartzite lode runs through the lease in a general north and south direction. This lode, the full width of which has not yet been determined, is being worked by means of four shafts, the deepest of which has been sunk to a vertical depth of 120 feet. On the north end of the lease a shaft has been sunk vertically for 100 feet, and a short level put in at 40 feet, and a somewhat longer one at 80 feet; this level has been driven about 40 feet north and the same distance south, and a crosscut has been put in westerly from it for a distance of about 90 feet; no stoping has been done. Of the three shafts at the southern end of the lease, the deepest is 120 feet and the other two 60 feet and 105 feet, respectively; from the latter of these, drives have been put in north and south at the 40, 60, 80, and 100 feet levels for about 100 to 120 feet each way, and a considerable amount of crosscutting and stoping has been done, the three shafts being connected at the lower levels.

The two largest gold producers in the Lennonville district are the Long Reef G.M. and the Wheel of Fortune North. These have respectively produced, to the end of 1902, 37,911·19ozs. from 54,766·25 tons, and 9,296·14ozs. from 3,123·00 tons.

The following tables, compiled from the latest official information, show the gold returns from the various leases in the district, other than those already mentioned, up to the end of 1902. It may be mentioned, however, that the majority of the leases named in

these lists have been abandoned for some years past, very little work having been done upon them :—

OUTPUT OF GOLD BY DISTRICTS.

LENNONVILLE DISTRICT.

NAME OF LEASE.	NO. OF LEASE.	TOTAL GOLD YIELD TO END OF 1902.		
		Ore Milled.	Gold Yield.	Average ozs. per ton.
		tons.	ozs.	
Agnes	302M	13'00	4'15	'32
Ardpatrick	613M	322'00	265'50	'82
Bushman	644M	19'00	13'00	'69
British Exploration Co., Ltd.	78, 74M	110'00	144'65	1'31
Briton	602M	28'00	6'63	'24
Canterbury	519M	301'00	392'58	1'34
Canterbury Extended No. 1 ...	459M	12'00	1'10	'09
Colonial Consolidated Finance Corporation Co., Ltd. late	80M, R.C., 2M	4,934'00	3,013'02	'63
Corsaire Consolidated G.M. Co.	80M, 345M			
Federal	407M	10'00	'55	'05
Geraldton United	144M	51'00	13'13	'26
Golden Gem	201M	550'50	1,371'79	2'49
Golden Giant Leases	47M, 179M	147'00	71'40	'49
Grand Gorge	549M	456'50	982'30	2'13
Haeremai	628M	54'00	90'25	1'67
Helm	494M	20'00	16'85	'84
Josephine	453M	6'00	'91	'15
Kathleen	559M	5'00	6'50	1'30
Keep-it-dark	393M	49'90	103'10	2'07
Klondyke	348M	36'00	*142'91	3'94
Lady Brassey	379M	97'00	203'35	2'10
Last Chance United	556M	54'00	17'07	'31
Lady of the Lake	486M	14'00	8'10	'57
Long Reef Central	542M	190'00	83'29	'44
Matterhorn	632M	12'00	3'80	'31
Magnet Gem	322M	22'00	14'18	'64
Merriwee	606M	22'00	37'37	1'70
Mabel	578M	118'00	28'35	'24
Mount Blanc	539M	14'00	3'00	'21
Murchison Boulder	425M	26'00	7'47	'28
Queenslander	552M	395'50	210'69	'53
Queenslander South	393M	1,135'00	967'40	'85
Rock of Ages	517M	181'00	141'44	'77
Rosella	412M	13'00	14'00	1'08
Royal Surprise	278M	36'00	9'72	'27
Scottish and Colonial	449M	10'00	2'00	'20
St. Albans	359M	45'00	56'20	1'25
St. Albans South	384M	105'00	90'80	'86
Victoria	480M	39'00	11'75	'30
Vicquary Piedmont	80M	2,061'00	1,408'00	'68
Viking	431M	20'75	25'57	1'23

* Includes 29'65ozs. dollied and specimens.

LENNONVILLE DISTRICT—*continued.*

NAME OF LEASE.	No. OF LEASE.	TOTAL GOLD YIELD TO END OF 1902.		
		Ore Milled.	Gold Yield.	Average ozs. per ton.
		Tons.	ozs.	
Wah Wah	420M	192·00	243·62	1·27
Waringee	341M	127·00	238·33*	1·87
Welcome News	395M	31·00	6·85	·22
Wheel of Fortune North ...	103M	3,123·00	9,296·14	2·91
Wheel of Fortune South Block	151M	926·65	3,401·25	3·64
Wheel of Fortune North, Extd.	109M	117·00	108·77	·92
Wrayfield	334M	114·75	133·00	1·16
Yuletide	198M	66·00	48·93	·74
Yuletide North	23M	334·00	205·44	·61

* Includes 3·35ozs. dollied and specimens.

MOUNT MAGNET DISTRICT.

Birthday	317M	184·50	30·92	·16
Black Diamond	304M	39·00	33·95	·87
Chums Consolidated, Ltd. ...	7M, 206M, 257M, 301M, 313M, 315·6M, 324M, 555·6M	11,984·00	28,503·15	2·38
Easter Gem	543M	33·00	20·73	·63
Evening Star	389M	30·00	5·25	·17
Gascoyne (Murchison) Gold- fields Exploration Co., Ltd.	49M, 56M	19·25	4·37	·23
Gay Parisienne	417M	534·85	160·21	·29
Golden Age	301M	77·00	109·65	1·42
Hector Hill	257M	24·00	7·55	·31
Homeward Bound	401M	76·50	148·16	1·94
Kapai	562M	61·00	32·99	·54
La Perola	370M	41·00	36·85	·90
Mayflower G.M., Ltd. ...	9M	174·00	287·98	1·65
Mt. Magnet G.Ms., Ltd. ...	64M, 319M, 399M	2,759·00	2,261·68	·82
Murchison	448M (9M)	588·00	559·29	·95
New Chum South Extd. ...	26M	163·00	28·70	·11
New Moon	371M	286·00	187·20	·65
Old Jock	560M	12·00	12·85	1·07
Pearl of Ben Rose	45M	66·00	33·25	·50
Primrose	339M (32M)	135·00	88·95	·66
Pearl North	623M	13·00	20·00	1·54
Revenue	572M (565M)	182·00	65·00	·36
South Pearl	2M	11·00	12·45	1·13
Tarquin	63M	50·00	25·00	·50
Waikawa	565M	44·00	34·15	·77
Western Syndicate, Ltd. ...	120M, 339M	876·00	* 1,436·92	1·64
White Rose No. 1 North ...	29M	51·00	5·65	·11
L.C. 87	L.C. 87	28·00	13·25	·47

* Includes 6·04ozs. dollied and specimens.

BOOGARDIE DISTRICT.

NAME OF LEASE.	No. OF LEASE.	TOTAL GOLD YIELD TO END OF 1902.		
		Ore Milled.	Gold Yield.	Average ozs. per ton.
		tons.	ozs.	
Bobbie Burns	462M	19'00	6'25	'32
Bobs	594M	65'00	64'25	'99
Bonanza	184M	40'00	20'00	'60
Boogardie	351M	16'00	4'52	'28
Briars	553M	12'00	21'60	1'80
Bronzewing	507M		47'75ozs. dollied and specimens.	
Constellation	337M	20'00	6'50	'32
Deep Alluvial Claim	A.C. 1	2,392'00	959'84	'40
Eclipse	172M	400'00	*826'25	2'05
Eclipse North	411M	104'00	23'76	'22
Emily Bennett	530M	15'00	3'40	'22
Exchange Leases	185M, 281M	159'00	145'05	'91
Federal	520M	14'00	7'65	'55
Federation	410M	12'50	†113'65	9'09
General Roberts	500M	74'00	51'70	'70
Golden Crown	173M	121'00	232'90	1'92
Golden Point	224M		7'60ozs. dollied and specimens.	
Grosotto	438M	110'50	163'60	1'49
Havelock Extended	335M	93'00	47'35	'51
Havelock Proprietary	328M	42'00	\$118'34	2'82
Hesperus	491M	6'00	6'12	1'02
Jupiter West	504M	53'00	29'05	'54
Iron Dyke	635M	6'50	||5'63	'87
Lone Hand	435M	25'00	5'20	'20
Lucknow	226M	610'00	766'17	1'25
Magdala	518M	28'00	9'25	'33
Meteor	148M	51'00	51'70	1'01
Midlothian	182M	12'00	11'10	'92
Mystery	456M	66'50	26'13	'39
National	347M	11'00	5'15	'47
New Year's Gift	292M	20'00	20'60	1'03
Nil Desperandum	391M	57'00	40'60	'71
O.K.	160M	55'30	†198'30	3'40
Pick-me-up	513M		8'62ozs. dollied and specimens.	
Planet	65M	247'00	149'25	'60
Rock of Cashel	307M	24'00	8'55	'35
Rose, Shamrock, and Thistle	426M	90'00	20'75	'23
Saturn	538M	98'00	37'85	'38
Star of the West	455M	238'00	380'70	1'60
Sun	555M	17'00	3'10	'18
Three Star	332M	106'50	**630'03	5'91
Venus	479M	279'00	1,527'48	5'48
Waverley	470M	200'00	83'85	'42
Wellington	353M	18'00	28'10	1'56
Western	469M	60'00	23'15	'38
Q.C. 77	Q.C. 77	43'00	2'12	'40

* Includes 4'80ozs. dollied and specimens. † Includes 2'70ozs. dollied and specimens.
† Includes 73'05ozs. dollied and specimens. ‡ Includes 45'15ozs. dollied and specimens.
‡ Includes 20ozs. dollied. ¶ Includes 38ozs. dollied and specimens. ** Includes 61ozs.
dollied and specimens.

OUTPUT OF GOLD BY LINES OF REEF.

NAME OF LEASE.	NO. OF LEASE.	TOTAL GOLD YIELD TO END OF 1902.		
		Ore milled.	Gold Yield.	Average ozs. per ton.

EMPRESS REEF.

Empress	Leases	465m	tons. 1,335'00	ozs. 2,724'61	2'04
Empress North		583m			
Empress South		503m			
Empress Extd.		544m			
Total ...	...	...	1,335'00	2,724'61	2'04

BROOKLYN REEF.

Brooklyn ...	...	573m	80'00	201'25	2'51
Brooklyn North...	...	591m			
Brooklyn Block...	...	610m			
Brooklyn South...	...	605m			
Total ...	...	...	80'00	201'25	2'51

GALTEE MORE REEF.

Galtee More ...	...	343m	3,087'00	1,847'74	'59
Galtee More North	...	581m			
Galtee More South	...	505m			
Total ...	...	...	3,087'00	1,847'74	'59

SIMMER AND JACK REEF.

Simmer and Jack	...	586m	150'00	64'89	'43
Day Spring	...	593m	41'50	45'35	1'09
Day Spring North	...	597m	...	...	...
Splendour	...	421m	518'25	499'82	'96
Mermaid...	...	557m	187'50	229'58	1'22
Total ...	...	...	897'25	839'14	'93

GAMBIER REEF.

Tarcoola ...	...	590m	54'00	38'15	'70
Gambier ...	...	535m	125'50	124'20	'99
Gambier Extd.	...	554m	...	...	...
Total ...	...	...	179'50	162'35	'90

NAME OF LEASE.	NO. OF LEASE.	TOTAL GOLD YIELD TO END OF 1902.		
		Ore Milled.	Gold Yield.	Average ozs. per ton.

LONG REEF REEF.

		tons.	ozs.	
Long Reef	30M	54,766·25	37,911·19	·69
Long Reef North	31M	153·00	206·80	1·35
Long Reef South	433M	...	...	...
Total	...	54,919·25	38,117·99	·69

BURRA BURRA LINE OF REEF.

Last Chance	541M	54·00	20·55	·38
Burra Burra	327M	} 1,133·50	3,468·95	3·06
Burra Burra Extended	346M			
Burra Burra South Extended	368M			
Total	...	1,187·50	3,489·50	2·93

LENNONVILLE LINE OF REEF.

Brilliant	48M	52·700	564·15	1·07
Lennonville	512M	395·00	824·80	2·09
Moonstone North	595M	} 10·00	3·50	·35
Moonstone South	601M			
Total	...	932·00	1,392·45	1·49

WELCOME REEF.

Golden Giant West	143M	80·00	68·85	·86
Sullivan's Dunlop	405M	609·00	584·65	·96
Welcome	57M	1,860·00	*6,259·19	3·36
Baxter's Reward	604M	139·00	26·55	·19
Total	...	2,688·00	6,939·24	2·53

* Includes 2,550·00ozs. doliied and specimens.

FAIR PLAY REEF.

Occidental Extended	508M	57·50	100·65	1·75
Golden Treasure Leases, G.O.M.	41M, 508M, 52M	1,433·00	984·36	·69
Fair Play	333M	411·00	773·02	1·88
Speedwell	436M	21·00	35·65	1·70
Occidental Leases	66M	87·80	156·92	1·78
Total	...	2,010·30	2,040·60	1·01

SOURCE OF ORE.	TOTAL YIELD TO END OF 1902.		
	Ore Milled.	Gold Yield.	Average ozs. per ton.

MISCELLANEOUS RETURNS.

	tons.	ozs.	
Sundry claims at Boogardie	1,450'50	* 688'72	·47
Do. do. Mt. Magnet	1,944'60	† 2,549'02	1'31
Do. do. Lennonville	593'25	‡ 472'22	·79
From district generally—		ozs.	
Sundry parcels treated at Australian Gold Recovery Works		5,009'40	
" " " New Chum Works		1,382'75	
" " " State Battery, Lennonville		2,859'37	
Alluvial		613'83	

* Includes 5'86ozs. dollied and specimens.

† " 23'07ozs. " "

‡ " 13'50ozs. " "

Total gold yield from district embraced within the limits of the area referred to in this report up to end of 1902 is synoptically shown in the following table:—

	Alluvial.	Tons Crushed.	Gold Yield.	Average ozs. per ton.
	ozs.		ozs.	
Boogardie	...	15,800'83	* 18,538'50	1'17
Mt. Magnet	...	91,940'20	† 82,958'11	·90
Lennonville	...	84,079'10	‡ 80,811'80	·96
District generally	613'83	—	9,251'52	—
Total	613'83	191,820'13	191,517'93	·99

* Includes 1,052'13ozs. dollied and specimens.

† " 29'11ozs. " "

‡ " 2,642'48ozs. " "



1903

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 8.

GEOLOGICAL SKETCH MAP

TO ACCOMPANY REPORT ON

*Lennonville, Mount Magnet,
and Boogardie,*

MURCHISON GOLDFIELD

BY

CHAS. G. GIBSON, B.E.,

Assistant Geologist.

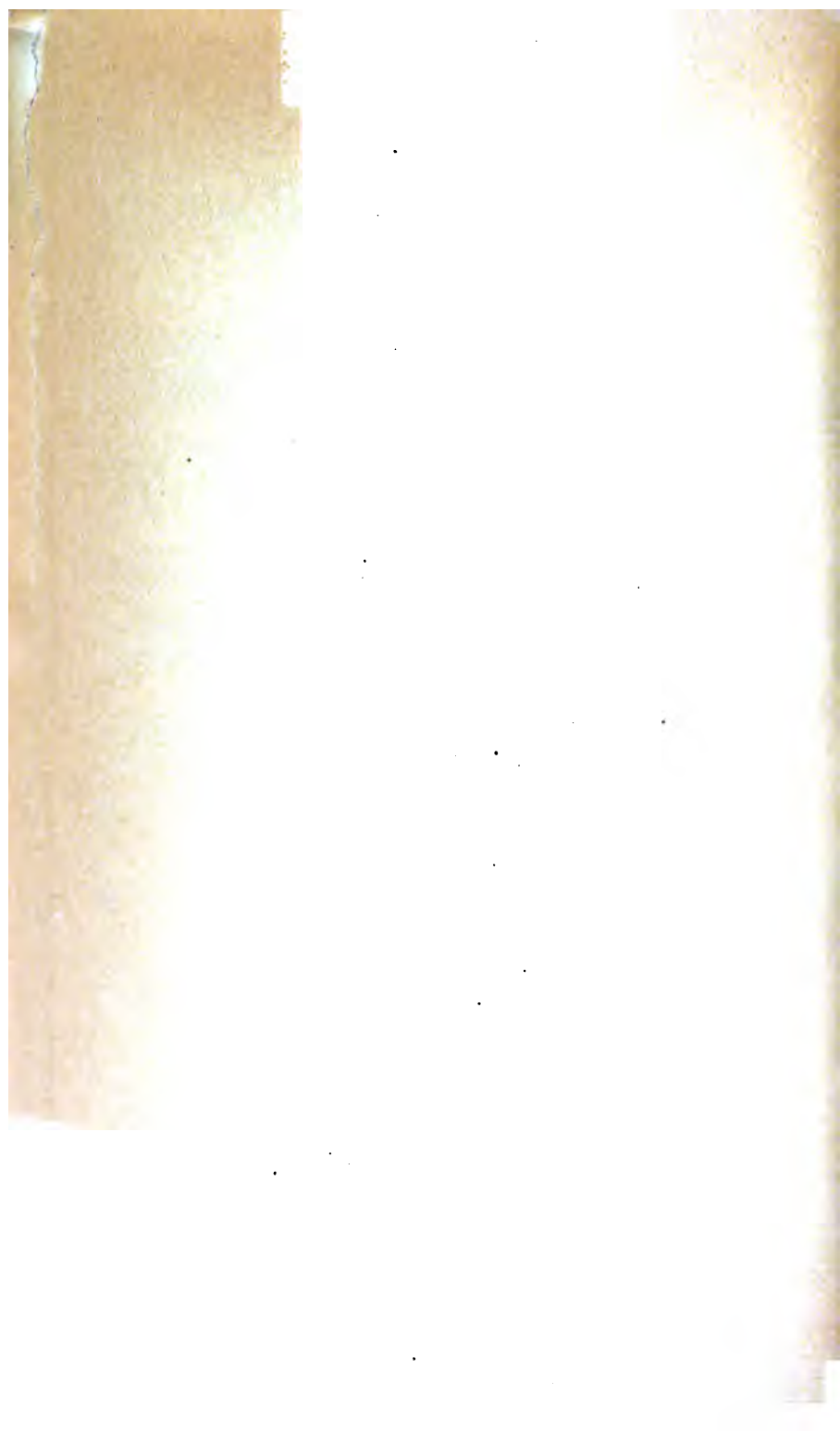
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Minister for Mines.*



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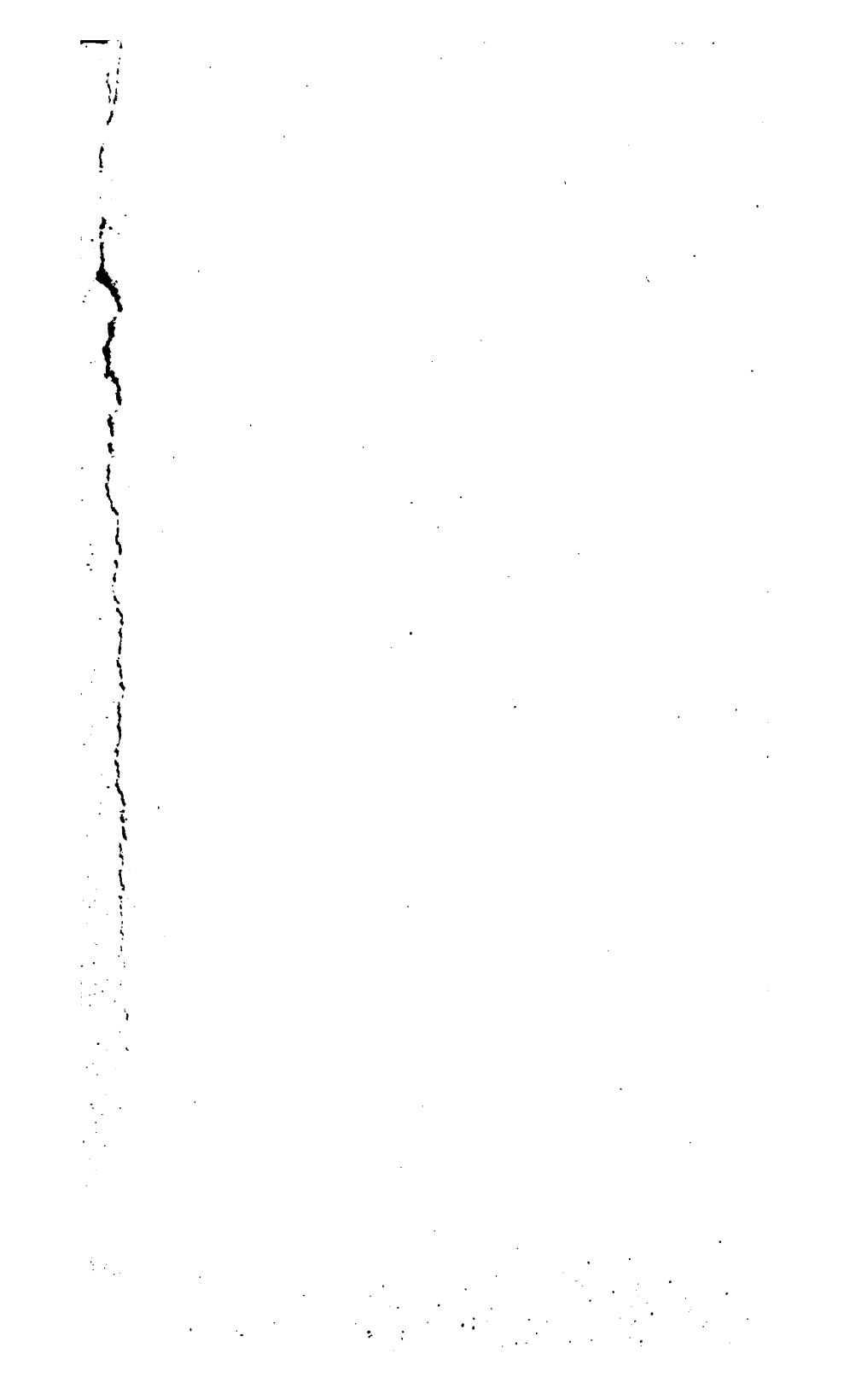
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WESTERN AUSTRALIA.

*From the Government Geologists
Compendiums.*

GEOLOGICAL SURVEY.

BULLETIN No. 9.

THE
Geological Features and Mineral
Resources of Northampton,

BY

A. GIBB MAITLAND,
Government Geologist,

WITH

APPENDICES

BY

H. P. WOODWARD, JOHN PROVIS, and E. S. SIMPSON.

*Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.*

WITH A MAP AND SECTIONS.



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1903.



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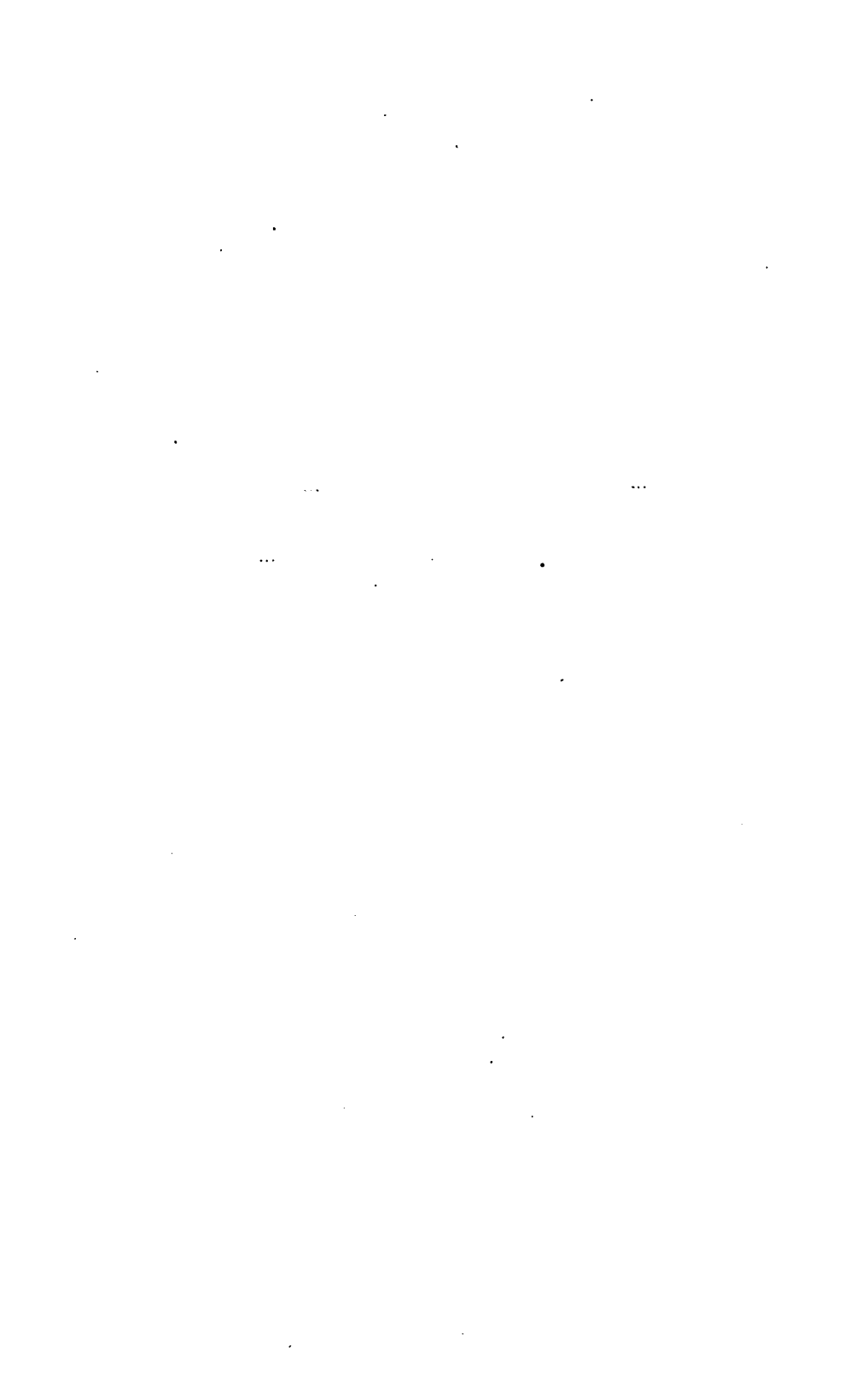
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PLATE.

Sections showing results of Boring for Copper and Lead in the
Northampton Mining District.

MAP.

Geological Map of Northampton: A. Gibb Maitland.



PREFATORY NOTE.

CONSIDERABLE attention having been directed to the resources of the Northampton District, the Hon. the Minister for Mines determined upon the publication of the Departmental Reports presented to the Government from time to time, but which, up to the present, have never been issued in such a form as would render them readily accessible to the general public.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Beaufort Street,
Perth, 1st July, 1903.



THE GEOLOGICAL FEATURES AND MINERAL RESOURCES OF NORTHAMPTON.

The month of January, 1897, found me at Northampton, engaged upon an examination of the geological features of the lead and copper mining district.

The ground, which was examined and mapped in some detail, embraces an area of about 100 square miles, and is depicted on the accompanying map, which has been photographically reduced from the large scale Geological Map of the district.

Mining in the early days was carried out in the most parsimonious manner, and sinking was discontinued when the lodes showed signs of contracting—a condition, however, to which all such deposits are subject. This circumstance, coupled with the low price of both lead and copper, would appear to have been the reason which led to the suspension of mining operations.

Mr. F. T. Gregory, writing* in the year 1861, would seem to have been the first to describe the occurrence of the lodes of lead and copper, in the following words:—

“These lodes take an almost invariable direction of N. 32° E., with a general dip of about 80° to the W.N.W., and are accompanied by parallel dykes of whinstone, quartz, or porphyry, varying from a few feet to 50 or 60 yards in breadth.”

In the year 1871 Mr. H. Y. L. Brown, at that time Government Geologist, examined the neighbourhood, and in his report † gave a description of such of the properties as were then accessible. This report, and the accompanying small scale map, is long since out of print. Mr. Brown, who had far better opportunities of examining the mines than any of his successors, wrote in no uncertain terms as to the district affording a wide field for the profitable employment of capital.

The report of Mr. Brown was followed in 1888 by that of Mr. H. P. Woodward, who noted the difficulty he experienced in examining any of the mines, which were either full of water or

* On the Geology of a part of Western Australia.—Q.J.G.S.: London, 1861: Vol. xvii., p. 478. † Geological and Mining Report on the Champion Bay Mining District, Western Australia. Perth: By Authority, 1871.

otherwise inaccessible. By far the best description of the copper and lead mines of the district is that from the pen of this author in 1895.*

My own visit added nothing to our knowledge of the underground workings, which were even in a worse condition than when visited by my predecessors, and were absolutely inaccessible.

During the course of the examination of the district, I was forcibly impressed with the association described by Gregory † of the lodes with the basic dykes which traverse the country for considerable distances with a remarkably persistent trend. The dykes being of commercial importance, owing to their intimate connection with the deposition of metalliferous minerals, it seemed to me that the greatest assistance the geological survey could render to private enterprise in the district would be in the direction of accurately mapping these igneous rocks, and by so doing afford a reliable guide as to the horizontal extent of the ore bodies, and possibly lead to the discovery of others.

Owing, however, to the absence of a topographical map on a sufficiently large scale, upon which the geological features could be shown in sufficient detail, the geological survey had to be delayed until this had been accomplished. The topographer completed this work by the end of June, but it was not until the month of September that I was able to proceed to Northampton to put in the geological details.

The district under examination occupies an elevated tract of country, drained by the tributaries of the Bowes River, which all take their rise in the rugged hills forming the most northerly portion of the district under examination.

The banks of the more important watercourses, Udandarra Creek and Nokenena Brook, are skirted by a width, more or less great, of recent superficial deposits: these have been shown upon the map. It is worthy of note that Mr. F. T. Gregory, writing in 1861, ‡ notes the discovery by some member of his party of gold in these alluvial deposits in the Bowes River.

A series of sandstones and conglomerates once covered the whole surface of the ground, and now the only remnant left consists of an extensive tableland, whose extent is marked by a bold precipitous escarpment of several miles in length on the Eastern portion of the district. A similar tableland occupies the north-western corner in the vicinity of Wesine Well and Appedagena Peaks, whilst the series is represented on the south by a narrow bed, due south of Loc. 2190, drained by the southern waters of Nokenena Brook. Some of the sandstone beds are quasi-vitreous.

In one portion of the district is a comparatively thin bed of very ferruginous conglomerate, which contains a fairly large proportion of clayey matter. In its characteristic mode of weathering, the rock differs materially from that of the sedimentary beds beneath. ‡

* Copper and Lead Mines of the Victoria District, vide Mining Handbook to the Colony of Western Australia, Perth: By Authority, 1895. 2nd Edition, pp. 117-126.
 † Loc. Cit. ‡ This bed is in reality a residual conglomerate, to which the term laterite has been officially applied in the case of similar deposits in other portions of the State.

One section shows the conglomerate passing down insensibly into the underlying rocks. The ferruginous conglomerate is not, strictly speaking, horizontal, but seems to have adapted itself to the shape of the ground, forming as it were a thin covering, now partially denuded, which extended over the whole surface.

In a traverse from Northampton to the mouth of the Bowes River, these sedimentary beds are seen to consist of grits and flagstones, dipping at a low angle to the west, and are covered by the much newer beds of the Coastal Limestone Series. There is no evidence as to the geological age of the grits, flagstones, and conglomerates; they are, however, coterminous with those which form what is shown on all the maps as Moresby's Flat-topped Range to the south.

From beneath these sedimentary beds emerge those granites, gneisses, mica schists, quartz schists, etc., intersected by veins and masses of pegmatite, which, from an economic point of view, form by far the most important feature in the structural geology of the district, and cover the largest area of ground. It has been found quite impossible to draw any line separating each of these rocks, hence all have been delineated on the map by the same colour and symbol. In the absence of chemical analysis and microscopic examination, no further details can be given regarding these rocks.

The summit of a bare hill east of Brookside Farm is interesting, as showing a sheeted zone of micaceous and garnetiferous schist. The rock is traversed by bands of quartz, often much contorted and puckered, and stands out in such bold relief as to be readily followed by the eye across country. The general trend of these sheeted zones, as can be seen by an inspection of the map, is generally north-west and south-east. Another similar parallel sheeted zone of garnetiferous gneiss occupies the country to the north-east of the Baddera Mining Lease 1472, and an identical band makes its appearance to the south-east of Reserve 1374, at the foot of the sandstone tableland at the head waters of the Bowes River. What appears to be a continuation of this band is again visible on the surface in what is known as Poison Well.

A remarkably persistent band of quartz schist can be traced from the Two-mile Hill, just to the south of the limits of the map. The schist, which forms a bold topographical feature, forms a horse-shoe-shaped curve, passing through the Two-mile Hill and Trig. Station No. 18, and for some considerable distance further, occupying in all a distance of about three miles. The quartz schist has a steep dip to the East.*

In the bed of the Bowes River, just above the station, is a bed of very coarse pegmatite intersecting the gneiss; the pegmatite is about 10 to 12 feet in thickness, and has a general trend to the northwards. In portions of the pegmatite there appear to be bands of gneiss caught up in the rock mass.

* A much wider acquaintance with the geology of the mineral-bearing districts of the State leads me to believe that this quartz schist is merely another form of those laminated quartzites (cherts?) which form such a pronounced feature in certain districts.

The most important structural feature is the system of basic dykes with which the whole area is seamed; these extend far beyond the limits of the country examined. So far as my operations have extended, these dykes have no apparent connection with any visible deep-seated rock of similar composition. The basic rocks exhibit, when their trend is laid down upon a map with some degree of accuracy, a remarkable parallelism, having a general trend of north-east and south-west. The longest has been traced across country without interruption for a distance of over 10 miles, and extends, both north and south, far beyond the limits of the country examined. The breadth varies very much in different places, but in no case was the width exposed on the surface very great; although according to Mr. F. T. Gregory * the width of some of these examined by him reached as much as 180 feet. Wherever any sections were visible the dykes were either vertical or inclined at very high angles.

The rocks of which the dykes are composed are all basic compounds. An analysis of one of the most typical of these (200) from the vicinity of the crossing at Udandarra Creek, yielded at the hands of Mr. E. S. Simpson the following composition:—

Silica, SiO_2	53.06
Alumina, Al_2O_3	13.67
Ferric Oxide, Fe_2O_3	4.83
Ferrous Oxide, FeO	9.96
Manganese Oxide, MnO	0.56
Lime, CaO	8.62
Magnesia, MgO	5.31
Potash, K_2O	1.29
Soda, Na_2O	3.22
Loss on ignition	0.38
	100.90
Specific gravity... ..	
	3.07

This rock was found to be coarse grained, consisting almost entirely of multiply-twinned felspar and augite, together with a little magnetite.

FUTURE PROSPECTS.

Over the whole of the district under examination there is not a mine which has been sunk to a greater depth than 300ft., and operations ceased when the lodes showed signs of cutting out.

From an examination of the geological map of the district it can be seen that the area is traversed by a series of basic dykes which are continuous for miles, and that parallel to these are those lodes of lead and copper which have already been opened up in one or two localities. Igneous dykes of this nature represent what were originally fractures in the earth's crust, which pass downwards to very considerable depths, and the copper and lead lodes fill in fissures of a similar character, which find their origin far below the limit of practical mining. The lodes in consequence will continue downwards as far as ever operations are likely to be carried.

The method of the formation of fractures, and the movement of either of the walls, have the effect of producing alterations in

* Loc. Cit.

the nature of the fissures by forming wide or narrow portions, which have been subsequently filled with ore. There must always be local variations in the metallic contents of ore bodies, but there are no scientific grounds for believing that what may be called the shallow mines of the Northampton District have reached the limits of ore deposition, and that the ore bodies will not prove equally productive when followed either horizontally or vertically. As the deposition of the ore bodies is most intimately connected with the system of fracturing to which the district has been subject, it is evident that the search for further lodes must follow that direction which the evidence already accumulated has shown to be that of greatest ore deposition; and this direction is that which lies parallel to the system of basic dykes shown upon the map. A system of judicious prospecting carried out upon these lines should result in the discovery of other lodes equally productive to those already exploited.

THE OUTPUT OF ORE.

It appears that mining first commenced in the year 1842, and since that date 9,349·78 tons of copper and 33,643·85 tons of lead ore have been raised from the mines and exported from the district.

Unfortunately, it is impossible to give the output of the individual mines of the district, but I am under obligation to Mr. S. Mitchell, for the following returns shown in the tables appended. These, however, do not in all cases represent the actual output of ore, but are merely data of which a record has been kept; and on that account are worthy of record. These data have been compiled from the sale notes supplied to the vendors in England, where most of the ore had been sent; and the figures in the second column represent the value of shipments of copper and lead, from which it can readily be seen that ore of very different metallic percentages must have been raised.

Statement of Lead Ore raised from some of the Northampton Mines.

Name of Lease.	Date.	Quantity of Ore raised.	Total value of Ore.		
		tons cwt. qrs.	£	s.	d.
Baddera, No. 1	1883	40 0 1	299	6	0
Do.	1884	29 14 4	172	11	8
Baddera, No. 2	1884	14 9 0	67	5	0
Do.	1885	26 10 2	103	15	7
Do.	1886	0 8 2	2	10	11
Do.	1891	118 0 1	766	8	9
Geraldine, South	1886	6 8 0	44	17	8
Uga No. 1, South	1883	163 5 3	1,218	15	8
Do.	1884	51 19 2	277	17	10
Do.	1885	174 0 3	965	11	7
Uga No. 2, South	1883	13 6 1	80	17	7
Do.	1884	2 4 1	10	14	10
Wheal Ellen...	1883	0 4 2	1	16	4
Yiapa	1885	88 12 2	444	10	7
Baddera and South Uga	1884	143 14 0	789	1	5
Different Mines mixed	1890	74 9 1	483	8	4

Statement of Copper Ore raised from some of the Northampton Mines.

Name.	Date.	Quantity of Ore raised.	Total value of Ore.
		tons cwts. qrs.	£ s. d.
Gwalla	1863	12 3 0	260 4 8
Do.	1864	132 14 0	3,956 9 6
Do.	1865	88 11 0	1,866 16 9
Do.	1866	163 13 0	1,044 9 8
Do.	1867	172 7 0	2,976 1 1
Do.	1868	263 1 0	3,664 19 8
Do.	1869	70 18 0	904 7 1
Yanganooka	1866	292 0 0	3,725 16 7
Do.	1867	164 18 0	2,155 3 7

Appended will be found a table taken from the report of the Statist to the Mines Department, showing the quantity and value of copper and lead ore exported from the neighbourhood since 1850. The first shipment of ore from the district is said to have taken place during the year 1845, but no details as to either the quantity or the value are obtainable.

Table showing the Export of Copper and Lead Ore from the Northampton Mining District.

YEAR.	COPPER ORE.		LEAD ORE.	
	Quantity.	Value.	Quantity.	Value.
	tons	£	tons	£
1850	...	...	5'00	55'00
1	...	...	...	...
2	...	...	...	...
3	*	7'50	*	4'00
4	...	...	...	...
5	2'05	26'45	25'00	250'00
6	57'00	1,017'90	...	...
7	80'00	1,920'00	...	...
8	433'25	9,531'60	...	...
9	941'50	14,122'50	13'50	135'00
1860	517'50	8,021'25	98'50	985'00
1	409'00	6,339'50	79'00	790'00
2	783'50	12,536'00	9'00	90'00
3	763'00	12,208'00	230'00	2,300'00
4	1,076'00	17,216'00	80'00	800'00
5	886'00	13,290'00	703'00	8,436'00
6	557'50	8,362'50	273'50	3,282'00
7	337'00	5,055'00	902'00	10,824'00
8	83'00	1,245'00	1,100'50	13,206'00
9	155'00	2,325'00	699'50	8,394'00

* Declared weight not stated.

Table showing the Export of Copper and Lead Ore from the Northampton Mining District—continued.

YEAR.	COPPER ORE.		LEAD ORE.	
	Quantity.	Value.	Quantity.	Value.
	tons	£	tons	£
1870	6'00	90'00	1,209'50	14,514'00
1	...	...	420'00	5,040'00
2	...	...	364'00	4,368'00
3	58'50	847'50	965'50	11,586'00
4	68'50	997'50	2,143'75	25,725'00
5	204'75	3,071'25	2,289'00	27,468'00
6	279'00	4,185'00	2,191'50	26,298'00
7	53'50	802'50	3,955'50	47,466'00
8	9'00	135'00	3,617'50	43,410'00
9	...	...	2,775'00	33,300'00
1880	8'00	120'00	1,921'00	15,368'00
1	...	...	1,400'50	11,204'00
2	1'50	22'50	1,793'50	14,348'00
3	5'00	75'00	1,088'00	7,266'00
4	118'00	1,770'00	696'00	4,872'00
5	119'50	1,792'50	465'00	3,255'00
6	249'00	3,735'00	611'00	4,277'00
7	23'00	345'00	471'00	4,710'00
8	87'50	1,487'50	532'00	5,320'00
9	112'00	1,904'00	250'00	2,500'00
1890	8'00	136'00	213'50	2,135'00
1	...	...	25'00	250'00
2	155'00	2,377'20	29'75	150'00
3	...	...	...	...
4	...	...	...	...
5	24'00	120'00	...	...
6	...	...	...	...
7	21'15	302'00	...	4'00
8	†74'53	931'50	5'00	33'00
9	586'55	9,473'25	16'00	96'00
1900	...	...	26'85	242'00
1	50	10'00	...	...
Total	9,349'78	147,954'30	33,643'85	364,756'00

* Declared weight not stated. † 74 tons 10cwt. 2qrs.

A. GIBB MAITLAND,

Government Geologist.

APPENDIX A.

THE NORTHAMPTON MINING DISTRICT.

Although this district has the honour of claiming that it was here that the first mine opened in the whole of Australia, at the present time so little mining is being done that Northampton, which was once a flourishing mining centre, is now little more than a deserted village.

The mines in this district are for the most part situated upon private property, the titles being acquired with all mining rights many years ago, and, therefore, it is purely optional whether the owners work them or not. The majority of these properties fell into the hands of creditors at the time when the great fall in the metal market took place; and, since the present owners have no desire to launch into mining, but continue to hold the property until a purchaser presents himself, there is no immediate prospect of a revival taking place in the near future. The remaining properties which still belong to the Crown are, for the most part, insignificant, although one or two good lodes have been worked upon them.

This year only two or three leases have been taken up, but at the present time not a single one is being worked: the only lead production being by tributaries working over the old dumps.

WHITE PEAK COPPER MINE.—This mine is situated upon freehold block No. 4, between the railway line and the road nine miles north of Geraldton; in it a rich bunch of ore is said to have been met with and worked, but as no work has been done since 1858, and the shaft has fallen in, no very reliable information can be obtained.

GRAY'S LEAD MINE.—This mine is situated upon freehold block 29, which is a little over a mile to the north-east of White Peak railway station. A shaft was sunk upon this property, said to be 40 feet in depth, from which the lode was worked by means of levels, and a considerable quantity of ore is said to have been raised about 1866. The strange fact is that the manager did not seem to place any value upon carbonates, of which there are at least 20 tons still at grass. The lode is strong and well-defined, the cap being easily traced for a considerable distance north and south at the surface.

GELIRAH LEAD AND COPPER MINE.—This mine is upon freehold block No. 328, which lies close to and upon the eastern side of the railway line, about 12 miles from Geraldton. There are two parallel lodes, the most eastern of which outcrops for a distance of 300 yards, along which several shafts have been sunk to various depths of from 40 to 120 feet, from which a large quantity of copper is said to have been raised. The western lode has been traced at the surface for a distance of 200 yards, and has been

opened upon by a series of shafts. This lode was found to contain a considerable quantity of lead in places, associated with zinc blende and iron pyrites. These lodes strike north-east and south-west, and dip towards one another. A considerable quantity of both lead and copper ore is said to have been raised when this mine was worked prior to 1860, when it closed down, but was again re-opened for a short period in 1872.

OAKAJEE LEAD MINE.—This mine is upon freehold property No. 311, which is situated upon the eastern side of the railway line, 16 miles from Geraldton. The lode, which carries a considerable quantity of pyrites mixed with the galena, strikes 20 deg. east of north, dipping at an angle of 80 deg. to 85 deg. in a south-west direction, and has been opened by two shafts 40 feet in depth. The lode, although large, is not well defined, the galena being embedded in a mass of hard quartzite and granitic rock, containing much iron pyrites. This mine, although only worked upon a small scale, is said to have produced several hundred tons of ore prior to 1870, when it was closed down.

MCGUIRE LEAD MINE.—This mine is upon freehold block 332 upon the railway line, 25 miles from Geraldton, and was owned by the Melbourne and Champion Bay Smelting Company, who had their works upon this area, but at present the chimney stack is all that remains. One shaft has been sunk to a depth of 60 feet and one 30 feet, whilst there are several small pits and trenches upon a lode which evidently contained a considerable amount of copper mixed with the lead. This now belongs to the Fremantle Smelting Company.

KOBIJAWANNA LEAD MINE.—This is situated upon Crown lands upon the western side of the railway line, about half a mile north of McGuire. It is now partly included in the Railway Reserve, and is made the main settlers camp, owing to the fact that a splendid supply of water is obtainable from one of the old shafts. The lode has been opened up by a series of small shafts and pits for a considerable distance, and shows a rich body of carbonate ore in places. This has not been worked since 1872.

NAEBA TARRA COPPER MINE.—This mine is situated upon Freehold Nos. 118 and 119, being about 25 miles north-east from Geraldton and six miles east of the railway line. This is one of the old mines, which has not been worked since 1865, when three shafts were sunk to a depth of 20 to 25 feet, and some driving done. The lode is well defined, striking in a north-east and south-west direction, with an underlie to the north-west. From the two southern shafts copper was raised, but in the northern one galena was encountered; this at the time was thrown aside, but later on it was dressed and bagged. A little to the north-west there is the outcrop of another lode, which can be traced for a considerable distance, showing lead carbonates of good quality.

NAEBA TARRA LEAD MINE.—This consists of Freeholds 42, 336, 337, 830, and 833, and adjoins the last-mentioned to the

north-east. It was formerly worked by the Melbourne and Champion Bay Mining and Smelting Co., but now belongs to the Fremantle Smelting Co. All the lodes in the old mine run into it, whilst there is also a more western one, which is the main one, that has been worked. A vertical shaft, timbered and divided into three compartments, was sunk to a depth of 180 feet, with levels at 60, 120, and 180 feet. Owing, however, to the fact that it was sunk upon the cap of the lode, which was dipping to the south-east, crosscuts had to be driven from the shaft to the lode, the bottom one being 90 feet in length; it was therefore proposed to sink another shaft farther to the dip, with the object of cutting it at a depth of 300 feet, but, when this had been sunk 140 feet, the mine was abandoned. The lode near the shaft is said to have been nearly pure galena, from four to six feet in width. It is evident that a considerable quantity of work was done here, and a large plant has been in use, as well as smelting furnaces. Farther to the north-east are some more workings, where one shaft is down to a depth of 115 feet, and two or three other shafts of uncertain depth. The original management of this mine evidently failed to recognise the value of carbonates of lead, which were, in consequence, either not raised or tipped upon the dump; these are now being worked upon tribute, and 28 tons have already been dressed. This mine was worked from 1870 to 1884, during which time the company sent away £60,000 worth of ore. In the vicinity of these mines there are several other lodes which outcrop in places, upon which a little work has been done, but which have now been abandoned for many years.

NORMAN'S WELL LEAD MINE.—This abandoned mine is situated upon the Narra Tarra-Northampton road, about seven miles from the latter township. The lode is well defined, starting in a north-easterly and south-westerly direction, with an underlie to the north-west at an angle of 60° . There are several shafts, the deepest of which is 80 feet, and, to judge from appearance, a good deal of lead must have been raised. The old dumps have recently been dressed, and several tons of galena obtained from them.

GWALLA COPPER MINE.—This mine is situated upon the boundary of the township of Northampton, and consists of Freehold Blocks Nos. 140, 141, 250, 315, 331, and 359—covering a total area of 362 acres. There are two parallel lodes, which strike north-east and south-west, and dip to south-east. A considerable amount of work has been done upon the property, and several shafts sunk, the deepest being 198 feet upon the underlay. A main vertical shaft was in progress when the mine closed down, in 1868. This mine was only worked for a period of about five years, during which time 902 tons of ore, valued at £16,573, were raised. There were extensive buildings and plant upon this mine, most of which was left when the mine closed down.

WANERENOOKA COPPER MINE is situated at the north-west corner of the township of Northampton, and was worked about 45 years ago, but it was recently re-opened by an English company,

who did a considerable quantity of prospecting, but not finding any ore, closed down. The main shaft is 240 feet deep, from which there are several levels and drives, in which the lode proved to be about 30 feet in width, but carried rich ore in large bunches, sometimes upon one wall and sometimes upon the other. A winze has been sunk from the bottom level, in which there is said to be good ore. This company also owns Blocks 313, 27, 324, and 325, upon all of which lodes have been opened up to moderate depths.

WHEAL FORTUNE COPPER MINE.—This freehold property, consisting of Blocks Nos. 360, 334, and 437, is situated about three miles due west of Northampton. The main shaft on this mine is 300 feet in depth, and is connected with another, just outside the boundary, by a level some 500 feet in length. The lode when first opened up was only copper, but in depth a crosscourse was cut which carried lead, which cut out the lode, and thus the latter ore was worked. This mine was worked from 1862 to 1868, and produced 2,475 tons of lead and 985 tons of copper.

RHYS LEAD MINE.—This is on a freehold block, No. 436, which adjoins the Wheal Fortune upon the east, and into which the main lode worked upon that property runs; in fact, one shaft has been sunk in it. The workings upon this property are situated a little further eastward, upon a galena lode, which has been opened up to a depth of 50 feet. This mine has been worked recently, as there are several tons of ore, dressed and bagged, still on the dressing floor.

MARTIN'S SPRING COPPER MINE.—This mine is about three miles north of the Wheal Fortune, and is on a freehold block (No. 312) owned by the Wanerenooka Company. There are two shafts, the deepest of which is 42 feet, from which the lode was crosscut for a distance of 30 feet. Some of the copper from this mine carried a large percentage of silver, said to be as much as 50 ounces per ton. About a quarter of a mile farther south a third shaft has been sunk upon a lead lode, but little work has been done.

WOOMBOARO LEAD MINE.—This mine is on a small freehold block, about half a mile south of Martin's Spring, where a lead lode was opened upon many years ago, but is a series of shallow pits and trenches.

YANGANOOKA COPPER MINE.—This mine is about three miles north of Northampton, upon the main road, the area being held as freehold blocks, No. 32 and No. 314. There are two parallel lodes upon this property, which strike north-east and south-west, and dip at an angle of 75° north-west. The main workings are situated upon the western lode, which has been opened up by several shafts and levels, the deepest shaft being 180 feet. This mine has not been worked for 35 years, and the only record seems to be that the dressed ore went from 17 to 34 per cent., and the 458 tons sent away realised £5,880.

BADDERA LEAD MINE is situated upon Freehold Block 1472, about one and a-half miles to the north-east of the last mentioned.

There are two lodes upon this property, which run parallel in a north-east and south-west direction, dipping at a high angle to the north-west. These lodes vary from six inches to eight feet in width, the larger portion often consisting of almost pure carbonate or sulphide ore, which was so readily dressed by hand that the 677 tons of which a record has been kept averaged 72 per cent. The greatest amount of work has been done at the southern end of the lease, where the lode has been worked to a depth of 100 feet and 220 feet of drives. The other workings are at the north-east corner, where the lode has been opened up to a depth of 72 feet. This property was discovered in 1873 and worked for about 10 years, since which time little has been done. It now belongs to the Fremantle Smelting Company, who sunk a shaft to a depth of 160 feet, but stopped work before the lode was cut.

WHEEL MARY LEAD MINE.—This mine is situated upon a small freehold property about one mile south of the Baddera, and upon it a considerable quantity of work has been done; 2,200 tons of ore are said to have been sent away, but no work has been done during the last 12 years.

WHEEL ELLEN LEAD MINE.—This mine, No. 1146, is another freehold belonging to the Fremantle Smelting Works Company, being situated about a mile in a south-west direction from Northampton. This lode which strikes in a north-east and south-west direction and dips to the north-west, was first opened in 1872, and vigorously worked for about 10 years, during which time it is estimated that £16,000 worth of ore was raised. The lode has been worked to a depth of 158 feet and driven on 1,200 feet.

UGA LEAD MINE.—This abandoned lead lease was first opened in 1873. To judge from the extent of the old workings, the lode must have been of considerable size; whilst the refuse that remains after the ore dressing, proves that a large quantity of lode matter was dressed.

STRICKLAND'S BLOCK 326.—The southern continuation of the Uga lode extends into this property. It is very similar in character, being well defined and of considerable width and length of chute. These two mines are said to have contributed a considerable proportion of the ore exported between 1873 and 1884, when the price of lead dropped.

NOOKA LEAD MINE.—This abandoned lease is situated nearly one mile north of the last mentioned, which it greatly resembles in character. It was opened upon to a depth of 90 feet, but a large quantity of the work consisted of open trenches and underlay shafts. This mine was worked in the later seventies, and is said to have produced about 1,000 tons of ore.

CHIVERTON LEAD MINE.—This is also an abandoned lease, which adjoins the Nooka to the south, and into which that lode runs. This, however, has not been opened upon, but a parallel lode upon the western side of the lease has been worked to a limited

extent. This lode dips towards the Noska lode, which it will probably junction with at a depth.

KIRTON'S LEAD MINE.—This group of three abandoned leases was formerly known as Kirton's and West Wheal Virgin, and upon them a line of lode was opened for a distance of half a mile, there being three large chutes in this district, which have been worked upon, the three leases at the southern part to a depth of 100 feet, and the northern to 160 feet. In the central lease, whilst the Fremantle Smelting Company were prospecting, a low grade lode was driven through for a distance of 30 feet without any walls being met with. This mine was worked from 1873 to 1884, and was extremely rich in parts, being said to have yielded from four to six tons of clean galena per fathom in sinking.

YIAPA LEAD MINE.—This is a small lease about six miles north of Northampton, and it is the farthest north of the group around that township. It is now held by Mr. Reynolds, who has a shaft down 90 feet, which is worked by a horse whip; there is another shaft down about 40 feet. This mine seems to be situated at the intersection of a mineral vein with a dyke, the ore chute being short, but rich. The shafts are now full of water.

ALMA LEAD MINE.—This is a small lease situated a little nearer to Northampton than the last mentioned, upon the western side of the road, and is held by Mr. Harvey, who has sunk a shaft to a depth of 42 feet, from which a little stoping has been done. The cap of the lode has also been opened by a series of small shafts and trenches. Twenty-eight tons of ore have been shipped from this mine.

WHEAL MARGARET COPPER MINE consists of a number of abandoned leases about one mile east of Northampton. The lode is from seven inches to two feet in width, but pretty rich ore, and was worked by five shafts, close together upon the central lease, to a depth of 180 feet upon the underlay, and the chute stoped for a length of 200 feet. Very little has been done upon the other leases, although the continuation of the lode can be traced.

VICTORIA COPPER MINE.—There are also a series of abandoned leases about half a mile south of the last mentioned, but, as upon the Margaret, although the lode can be traced for a considerable distance, it has only been worked at one point by two shafts about 100 feet apart. The great difficulty here was the great influx of water, whilst the ore was mixed with a large proportion of mundic.

WHEAL ALPHA COPPER MINE.—This is also an abandoned lease, upon which a considerable amount of work has been done to a depth of about 60 feet. An attempt was recently made to sink a new vertical shaft, but this was abandoned.

YANKEE CROSSING COPPER MINE.—This is another small abandoned lease, adjoining the Gwalla, and in this property a small but rich chute was worked to a depth of about 40 feet.

GERALDINE LEAD MINE.—This mine is situated upon Freehold Block No. 1, 40 miles north of Northampton, upon the Murchison River. It was worked from 1857 to 1878, during which period a considerable quantity of lead was raised and dressed. In the very earliest days smelting was attempted, but this proved a failure, so the ore was shipped from Port Gregory; but since no record of the ore shipped from this port has been kept independently of the general shipment, the quantity raised from this district cannot be estimated. The deepest shaft is 320 feet on the incline, and from this and the others there are very extensive workings.

LADY FLORENCE LEAD MINE is about one mile lower down the river upon Location 2, which belonged to the same company as the preceding. It is apparently a large, well-defined lode, which was worked by a number of shafts to a depth of from 60 to 80 feet, the ore being dressed at the Geraldine.

NORTH GERALDINE LEAD MINE.—This is situated about one and a-half miles east of the Geraldine, upon Location 4, which was owned by the same company. It has not been extensively worked, the deepest shaft being only about 50 feet.

SOUTH GERALDINE LEAD MINE is situated upon Location 9, about two miles south of the Geraldine. This mine has not been worked for at least 20 years, but prior to that about 500 tons of galena are said to have been raised. The only shaft is down about 66 feet, but in it the lode is said to have been very rich.

LOCATION No. 7 LEAD MINE.—This mine is owned by the Wanerenooka Company. It was worked from 1888 to 1890, and is said to have yielded about 700 tons of ore. The deepest shaft is 44 feet, from which the lode has been driven upon, which proved to be very rich and pure.

GERALDINE COPPER MINE.—This mine, which consists of a number of leases, is situated about four miles north-east of the Geraldine mine. It is not being worked at present, but is still held. A shaft has been sunk to a depth of 150 feet, from which the workings are of considerable extent, which proves the existence of a very large lode, which is rich in places; 130 tons of ore, assaying 28 per cent., has been sent away the last year.

LADY MAUDE LEAD MINE is a lease a little to the eastward of the last mentioned. It has been opened up to a depth of 50 feet, and from it 60 tons of galena have been shipped.

OURAKA COPPER MINE is a lease a little south of the last mentioned. It has merely been prospected to a depth of 80 feet.

HENNINGS COPPER MINE.—This is merely a prospecting show, a few pits having been sunk, and about five tons of ore raised from a small but rich vein.

TAMBARRA COPPER MINE is a little north of the last mentioned, to which it is similar, the deepest shaft being 15 feet.

GIBSON'S COPPER MINE is one of the same group, just to the north of the last named. It has been opened to a depth of 40 feet

upon a low grade lode, in which there is a rich ore chute, which increases in width from two inches at the surface to 18 inches at the shaft bottom.

TWO SISTERS LEAD MINE.—These were two old leases held and worked by the Geraldine Company, who opened up a lode at various points for a distance of half a mile. The deepest shafts are from 60 to 70 feet, but the whole of the lode has been taken out up to the surface, and appears to have been from 10 to 15 feet wide at the chutes.

FOUR MILE POOL LEAD MINE.—This lode is situated south-west of the last, and is probably only the same vein; only a little work has been done on it of a purely prospecting nature.

MARY SPRING LEAD MINE.—This old mine, that was worked by the Geraldine Company, is about four miles north of the Geraldine Copper Mine, and on it two parallel lodes have been worked to a depth of 75 feet, from which, apparently, a large quantity of ore was taken and dressed at the Geraldine.

LADY TILLY LEAD MINE is about one and a-half miles north-west of the Geraldine Copper Mine. Very little work has been done upon it, but 120 tons of ore is said to have been shipped.

WHEAL LILY LEAD MINES is situated upon the south side of the river, about three miles east of the Geraldine mine. There are several old shafts, but as the ore has been stoped to the surface, these have mostly fallen in. The lode was apparently of good size, and a good deal of ore is said to have been sent away.

GENERAL.—It will be seen from the above that in all 45 properties are included, out of which 16 are copper and 29 lead, whilst 22 are situated upon freehold property, and 23 upon Crown lands. With the exception of one or two, the freehold properties are by far the most valuable, but since no regulations apply to them, there is no prospect of their being worked. The four most important lead mines were the Geraldine, the Narra Tarra, the Wheal Ellen, and the Baddera; and they are all freehold. With regard to the copper mines, the same remarks may apply, since there is no single leasehold copper mine that has acquired any prominence as an ore producer. If, however, an average is struck, we find that in the last 50 years the 16 copper mines have produced about 8,000 tons of ore, and the 29 lead mines 33,500; or 500 tons of copper and 1,155 tons of lead to each mine.

At the present time there are only a few small lodes that could be made productive without the expenditure of considerable capital. This condition of things is really the fault of the local miners, who, in their desire to obtain every scrap of ore, have rendered the workings not only unsafe, but have precluded their use for further development or prospecting, thus entailing the necessity of shaft sinking to a depth of 100 feet and more, in order to prove whether a payable lode does exist or not.

30th May, 1901.

H. P. WOODWARD.

APPENDIX B.

RESULTS OF BORING.

In the year 1901, Messrs. Woodward and Lightly were commissioned to visit the Murchison district in connection with a proposal to erect State smelting works at Geraldton. As a result of their investigations it was recommended, *inter alia*, that a diamond drill be sent up to the district with a view of testing some of the lodes at a depth. Instructions were ultimately issued for the selection of sites for experimental boring to be carried out on Crown Lands.

A site was eventually selected at the Wheal Margaret Copper Mine. The lode is embraced within the limits of a number of abandoned leases, lying about one mile to the East of Northampton. The "Wheal Margaret" lode is said to have varied from seven inches to two feet in width of pretty rich ore. The lode was originally worked by five shafts, which were put down in close proximity in the central lease to a depth of 180 feet in the underlay, and the chute stoped out for a length of 200 feet. Boring operations commenced on the 12th of July, and were suspended on the 8th of October, after the drill had penetrated to a depth of 651 feet. Operations commenced at a point about 257 feet from the outcrop, and boring was carried out at an inclination of about 59 degrees from the horizontal. The bore proved unsuccessful; full details of the strata pierced are found in the Plate herewith. It is conceivable that what is shown in the bore record as fault rock (lode stuff?) occurring between 387 and 408 feet, may represent the Wheal Margaret lode, occurring along a line of fault; if so, the drill pierced the deposit at a point where it happened to be poor. The total cost of the bore, including incidentals, etc., amounted to £807 16s. 5d.

The second bore was put down at the Old Cow Rock, at Narra Tarra, at an angle of 45 degrees. Operations were commenced on the 1st of November, 1902, and ceased on the 3rd February, 1903, having penetrated to a depth of 600 feet. The drill passed through more or less decomposed granite. At 83 and 90 feet, bands of decomposed rock, with a little copper sulphide, were passed through, and at 239 feet a small quartz leader, carrying a little galena and zincblende, was met with. The bore-hole intersected no lode of any importance. Particulars of the strata pierced will be found on the accompanying Plate.

The total cost of this hole amounted to £635 18s. 11d

A. GIBB MAITLAND,

24th April, 1903.

Government Geologist.

APPENDIX C.

THE NORTHAMPTON MINING DISTRICT.

According to instructions received from the Honourable the Minister for Mines, I paid a visit to Northampton, leaving Perth on the 17th May, and returning on 2nd June.

As far as I can gather, the first discovery of copper ore was made in this district in 1842, when the Wanerenooka mine was discovered, and operations were commenced and continued actively for some 10 or 12 years after. Several other copper mines were subsequently opened, then lead mines; the lead mines ultimately predominating over the copper mines in the larger output.

The value of lead ore raised in this district up to 31st October, 1899, is given me as £364,514, being the value of 33,617 tons of ore shipped. The value of copper ore raised up to 31st October, 1899, is given as £457,944 from 9,349 tons of ore. For the last 30 years the district has been practically idle. No mines are now being worked, and the miners seem either to have left the district or settled down to farming in the immediate vicinity of the mines.

The district is about 110 miles in length, and extends from the Geraldine mine on the Murchison River in the north, to the Irwin River in the south, and is about 30 miles wide.* Throughout the whole district, mining has now entirely ceased, and it is pitiable to see so much utter desolation and abandonment as the shafts present with their surface timbers and collars all removed, and the sides caved in. The refuse heaps have been picked over and over again, so that they are now as clean and free from payable ore as they can well be.

The mines I visited were as follow :—

WANERENOOKA MINE.—It is situated on the northern boundary of the township of Northampton, on Block 27. Its area is 60 acres. A considerable amount of work has been done here. There is a good three-compartment shaft sunk to a depth of 240 feet vertical. The lode is reported to have passed through the shaft at the 180 feet level, and since then has not been seen. There is an open cut for about 250 feet north of the main shaft, which has been filled in with waste rock. Ore is reported to be standing at the 138 feet level and at the 180 feet level. Galena occurs occasionally with the copper ore, but I was unable to ascertain if any had been sold. About 120 feet north-east from the shaft a winze has been sunk 60 feet below the 180 feet level which carries a bunch of black ore, said to be rich enough to pay working expenses. The walls of the lode are stated to be 30 feet apart, smooth, and well defined, with a payable streak on the hanging wall and another on the footwall, averaging one foot in width. It is reported

* The proclaimed Mining District extends only as far south as the Chapman River, and is 67 miles in length and 24 miles in width in its widest part, from which it will be seen that the legal boundaries do not coincide with the geological boundaries.—A.G.M.

that it took two and a-half years to sink this shaft this last 60 feet, a work which could easily have been done in six weeks.

VICTORIA COPPER MINE.—There are two shafts here, situated on the crest of a hill and about 200 feet apart, from which a considerable amount of ore is said to have been raised. The ores are apparently yellow sulphides, although it is reported that a good body of black sulphides existed between the shafts, which, when extracted, realised sufficient to pay the entire costs of the eight men who were steadily working here. The ore-body is stated to have been two feet six inches wide, and the lode seven feet wide. There is a drive at 36 feet, connecting these two shafts. One of these is 60 feet deep and the other 50 feet deep. The lode may be traced on surface for a distance of two miles from these shafts. North-east from these shafts is another small shaft at about 60 feet distant, which is 25 feet deep. This mine is situated one mile and a quarter east from the railway station.

WHEAL MARGARET.—Several shafts have been sunk on this block. One, a two-compartment shaft, is said to be 30 fathoms deep, and a fair quantity of ore has been raised. Travelling north from this shaft are several shallow workings, from all of which ore has been raised. These workings have since caved in and are full of water. The ores found were principally green and blue carbonates. Sulphides are just coming in, in the bottom of the shaft. The property is situated one mile north-east from the railway station.

WHEAL FORTUNE.—There is a shaft here said to be 300 feet deep, which has an 8-inch cast iron water-pipe column standing in it. The mouth of the shaft is badly caved in, and I doubt if it would be economical to repair and clear it for further work. The refuse heaps seem to be soft clayey decomposed rock, and to have carried carbonate ores of good quality for copper. Working ceased here 35 years ago, and since then nothing has been done. Another shaft, known as the "Old Wheal Fortune," is situated in a hollow close by, where water would be expected to be plentiful. This is about four miles west from the railway station.

WHEAL FORTUNE EXTENDED OR RHY'S MINE.—Two small shafts have been sunk about eight fathoms deep, and there are some 60 bags clean galena ore lying at the surface. There are numerous shallow holes near the shafts from which ore has been taken out. A horse whim seemed to be the only machine used here. Everything seemed cleaned right up. The mine is situated three miles north-west from the railway station.

SOUTH KIRTON'S AND NORTH KIRTON'S.—These are a group of mines about four miles from Northampton. In South Kirton's there are two or three shallow workings near the bottom of a depression, but no ore is visible in any of them. The lode is traceable for a considerable distance along the depression. To the north of these workings is another shaft, near which is a pile of some 20 tons of lode matter which carries galena. This would require dressing before being fit for the market.

In the North Kirton's is a shaft on which an engine had been used, and a small heap of lode matter, said to have come from the bottom of the shaft, shows a little lead, say, from 5 per cent. to 10 per cent., in a quartz matrix. The lode has been traced on the surface for about 150 feet north from the shaft.

WHEAL BETA.—This mine was worked by T. Scott. Two shafts have been sunk, 120 feet apart, on the crest of a hill; one is 54 feet deep, and the other 49 feet deep. Everything in the shape of ore has been cleaned up, and the mouth of the shaft caved in. It is two miles from the railway station.

WHEAL MAY.—Three shafts have been sunk here, the deepest being 90 feet. About 250 feet of driving on the lode has been done. The lode averages 18 inches in width. There is a six-inch Cornish lift in one of the shafts and an engine to drive it.

Mr. Chism, a former manager here, tells me he took out 2,200 tons of lead ore, which realised £14 per ton. Work was suspended entirely, owing to a depressed lead market, and not from any want of lead ore or pinching of the lode.

BADDERA MINES.—These mines are situated about six miles from Northampton railway station, and, judging from the large heaps of lodestuff lying about, I should say that a considerable amount of work has been done. The mine was discovered in 1873, and afterwards fell into the hands of Messrs. Crowther and Mitchell. The old shaft is about 15 fathoms deep, and about 130 feet has been driven on the lode, which has been stoped away right to the surface from the level, said to be 25 feet deep. A vertical shaft has been sunk more recently. This is said to be 80 feet deep, and at the bottom a crosscut has been driven 36 feet to intersect the lode. Another shaft is said to be 14 feet deep. The lode is said to be in good ore under foot in the level, and, as far as I could see, this property would be very productive of lead ore if again worked.

UKKEHERI MINE.—This mine is about two miles north from the Baddera mine. There is one shaft about five fathoms deep, from which a little lead ore has been sold, but very little work has been done. It was worked in the early days by one John Hosking, and subsequently by James Mitchell.

YIAPA MINE.—A little work has been done on a lode 3 feet wide. A shaft has been sunk 90ft. in soft, easy ground. There is about 10cwt. galena on the floors and a small pile of two tons seconds. This mine has produced 500 tons to 600 tons of galena.

ALMA MINE.—A shaft has been sunk in soft, decomposed country 48 feet deep. A little galena is showing in the lode near the surface, which is about three feet wide. No walls are showing. The lode has been traced on the surface for a distance of 1,300 feet.

YANGANOOKA MINE.—An old working stopped many years ago. The shaft has fallen in and there is a general wreck. I saw some good stones of copper ore said to have come from the bottom of the mine. The mine is on private property, and I could get no information as to the size and productiveness of the lode.

IGA MINE is about quarter of a mile south of Yanganooka mine. Not much work has been done, but it is reported that some 400 tons of ore were shipped from here.

GWALLA MINES are located on the south side of the township of Northampton. The railway terminus is situated within the boundaries of the property. There are two parallel lodes, a shaft has been sunk to about 200 feet, and seems to have been well equipped with pumping and winding gear, and there has also been some attempts at ore dressing. It was discovered in 1863, and was very successfully worked for some time.

CAMP HILL MINE adjoins the Gwalla mines on the west. Two shafts have been sunk about 50 feet each. No information was available as to quantity and quality of ore yielded.

WHEAL ELLEN.—This has been one of the best lead mines in the district, and a large amount of work has been done, and there seems to have been a continuous chute of ore for about 300 feet in length on the surface. There was a pumping engine and dressing plant here in operation, and ores used to be dressed from the Baddera mines as well as the Wheal Ellen mines. This mine was first opened in 1872, and returned about 1,000 tons of lead ore per annum whilst being worked. This mine is said to be only 26 fathoms deep, and the length of the workings 200 fathoms.

STRICKLAND'S BLOCK, or South Uga, is about west of north from Wheal Ellen three-quarters of a mile. This shaft is 12 fathoms deep, and I am told there is two feet of clean galena in the bottom of the shaft.

UGA MINE.—The shaft is 75 feet deep. This mine is said to have produced a large quantity of lead ore. The ore has been stoped up to the surface. The appliances for hoisting were too crude to enable them to go deeper.

CHIVERTON MINE.—This shaft is said to be seven fathoms deep. There is a little blende to be picked up on the surface, but not enough to be payable.

NOOKA MINES.—These have been fair producers. There is a quantity of blende associated with the lead ores. It is stated that there is a good body of blende opened up in the mine, which is 14 fathoms deep.

WHEAL ALPHA MINE.—This is about one mile and a quarter east from Northampton, and is a copper show. Three shafts have been sunk, the deepest being about 60 feet. The lode at the surface is one foot six inches wide. Water is stated to be plentiful here, and the ground seems favourable for the production of mineral. A vertical shaft sunk by Mr. S. Mitchell, 25 feet deep, did not reach the lode.

MARTIN'S SPRING MINE.—Two shafts have been sunk here, one 42 feet, the other 50 feet, and a level connects them. There are other smaller workings to the south on the same block. Lead and copper ore occur in the lode, and are said to contain an appreciable quantity of silver. A parcel of copper ore was sold at a very

satisfactory return, and was said to contain 55 per cent. copper. The lode is 25 feet wide, and the ore makes in bunches throughout the whole width of the lode. No walls have been reached in the last working. There has been about 20 tons of ore sold from here. No work has been done along the course of the lode.

SCOTT AND GALE'S MINE.—South of Martin's spring, on block 312, a shaft was sunk 54 feet, and a fair parcel of galena was sent away. The lode has been traced north from the shaft for a considerable distance.

Wanerenooka Estate have a block north of this, about a quarter of a mile distant, and a small working which is said to be on the same lode.

NORMAN'S WELL OR NORMANTINE MINE.—Several shafts have been sunk on the top of a hill, the lode showing clearly at surface for a long distance. One of the shafts has an abundant supply of good water, which is now being used to irrigate an orchard close by. The lode seems much mixed up with quartz and garnets where I saw it.

NARRA TARRA LEAD MINES.—These are situated some 13 miles south-east from Northampton. A considerable amount of work has been done here, and the lode, which is reported to have consisted of pure galena in places, is from four feet to six feet in width. The output from the mine is valued at £60,000, and the depth of the shaft at 30 fathoms. The mines seem to have been well equipped with machinery.

GENERAL.—There are also some mines at McGuire's, Oakajee, and White Peak. At White Peak but little work has been done. I saw some copper stains near one of the workings, but the ores were evidently poor in quality. At Gelirah, two lodes have been worked and a considerable quantity of copper raised. Time did not allow me to visit this mine.

ZINC BLENDE.—A careful search over the refuse heaps at the various mines visited leads me to the conclusion that blende was not so plentifully found as was generally reported. It certainly does occur in several of the mines, notably, Wheal Ellen, Nooka, and Uga mines, and at Nooka and Uga mines might pay to work in conjunction with the lead ores.

While I am satisfied that there are abundant supplies of lead and copper ores in the Northampton district, I am not so sanguine of their being worked at a profit owing to the present low price of lead and comparatively low price for copper. With galena and blende marketable something might be done, provided sufficient capital was available to give any one of the mines a thorough test. A pumping plant and small winding engine would be indispensable. With these provided, £5,000 should be able to thoroughly test a property, as the ground is not hard, nor are wages exorbitantly high.

JOHN PROVIS, F.C.S.,

Ass. Mem. Inst. C.E.

17th June, 1903.

Appendix D.

TABLE OF ASSAYS OF COPPER AND LEAD ORES
from the Northampton Mining District made in the Geological
Survey Laboratory.

Lab. No.	Mine.	Locality.	Nature of Ore.	Copper.	Lead.	Silver.	Gold.
				parts per 100.	oz. per ton.		
3105	Wanerenooka	Northampton	Chalcopyrite and quartz ...	6.54	Nil	...	...
M183	Nooka ...	do. ...	Chalcopyrite, galena, and quartz	5.34	8.6	Nil	Nil
...	Racecourse	do. ...	Cupriferous gossan ...	8.09	...	0.87	Nil
3905	Derby Syndt.	do. ...	Chalcopyrite and quartz ...	24.01	Nil	1.76	0.05
3906	Do.	do. ...	do. ...	13.52	Nil	0.44	Nil
673	?	do. ...	Malachite, iron oxides, etc.	18.63	...	2.29	trace
674	?	do. ...	do. ...	15.08	8.8	Nil	Nil
675	?	do. ...	do. ...	14.48	...	Nil	Nil
676	?	do. ...	do. ...	31.94	...	2.45	trace
677	?	do. ...	do. ...	37.85	...	...	...
672	?	do. ...	Galena and quartz ...	...	70.3	0.26	Nil
1559	Geraldine ...	Geraldine ...	Pyromorphite	Nil	62.5	Nil	Nil
4134	McGuire's ...	Oakabella ...	Galena, chalcopyrite, and quartz	1.75	39.5	Nil	Nil
3281	Lauder's ...	Narra Tarra	Cerussite ...	Nil	66.9	0.25	trace
3943	Mendip ...	do. ...	Cerussite and quartz ...	...	50.7	0.45	trace
3944	Do.	do. ...	do. ...	...	54.0	0.72	Nil
3945	Do.	do. ...	Galena, cerussite, and quartz	...	64.1	2.41	trace
8930	Narra Tarra	do. ...	Galena, blende, quartz, and granite	...	59.3	0.16	Nil
3931	Lead	do. ...	Cerussite, galena, and quartz	...	39.6	1.38	Nil
3941	Do.	do. ...	do. ...	...	52.4	3.76	trace
3942	Do.	do. ...	Cerussite and quartz ...	...	44.3	0.98	trace
4135	Do.	do. ...	Galena and quartz ...	...	59.5	Nil	Nil
3925	Narra Tarra	do. ...	Azurite and quartz ...	14.61	Nil	2.33	0.11
...	Copper	...	...	...	...	...	...
3926	Do.	do. ...	Azurite, malachite, and quartz	8.98	Nil	1.07	trace
3927	Do.	do. ...	Galena, cerussite, and quartz	...	46.7	0.57	Nil
3928	Do.	do. ...	do. ...	...	51.0	0.73	Nil
3929	Do.	do. ...	do. ...	...	63.2	2.94	Nil
4281	Gelirah ...	White Peak	Chalcocite, quartz and iron oxide	21.99	...	...	...

ANALYSIS OF A SAMPLE OF DARK BROWN ZINC BLENDE
from the Nooka Mine, Northampton.

Zinc, Zn	...	59.04
Cadmium, Cd	...	5.78
Iron, Fe	...	2.08
Lead, Pb	...	.37
Sulphur, S	...	32.66

99.93

Specific gravity ... 4.07

EDWARD S. SIMPSON, B.E., F.C.S.,
Mineralogist and Assayer.

1903.

WESTERN AUSTRALIA.

*With the Government Geologist's
Comments.*

GEOLOGICAL SURVEY.

BULLETIN No. 9.

GEOLOGICAL MAP

AND

**SECTIONS SHOWING RESULTS OF BORING
FOR COPPER AND LEAD,**

TO ACCOMPANY REPORT ON

**The Geological Features and Mineral
Resources of Northampton,**

BY

A. GIBB MAITLAND,
Government Geologist.

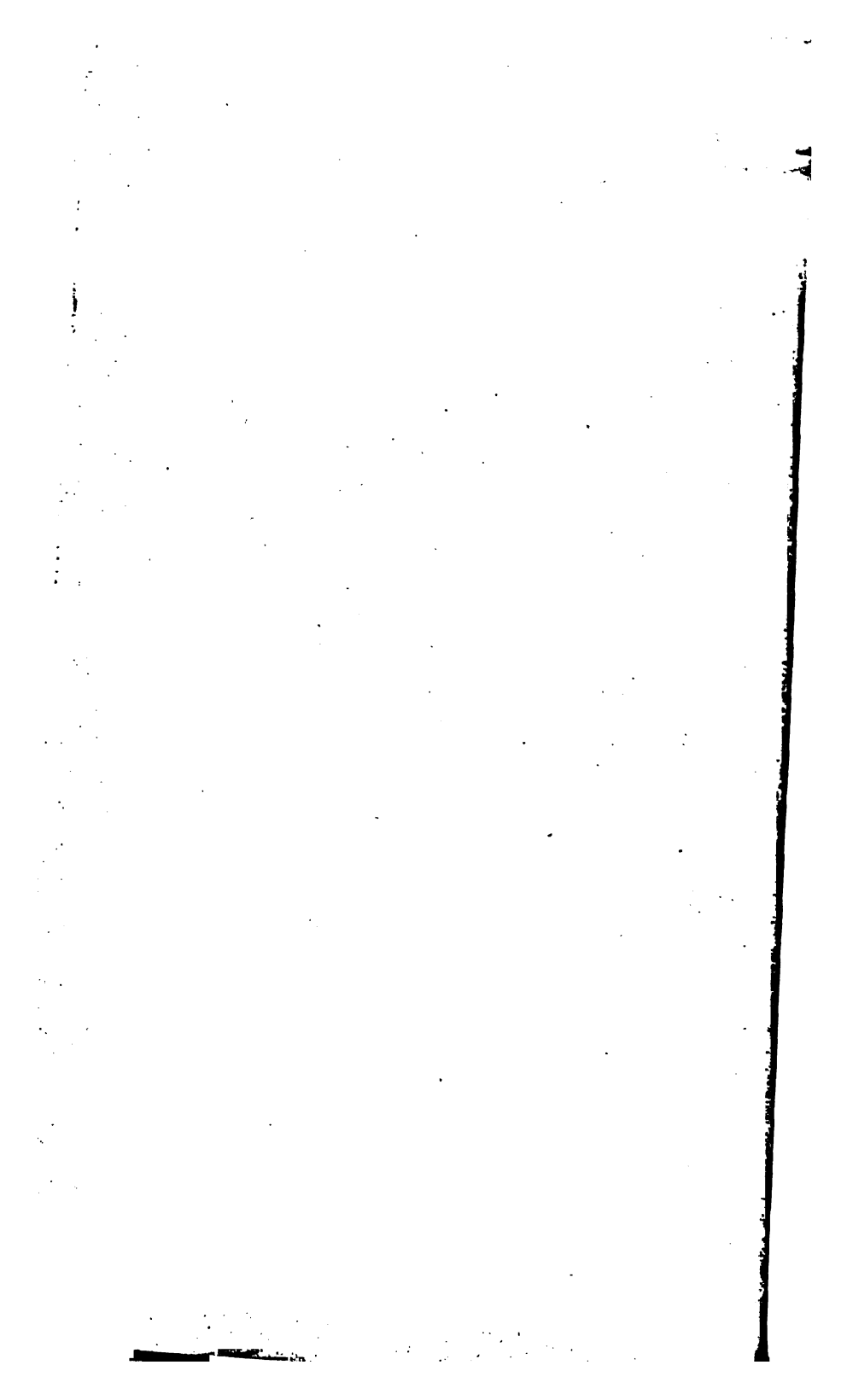
*Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.*

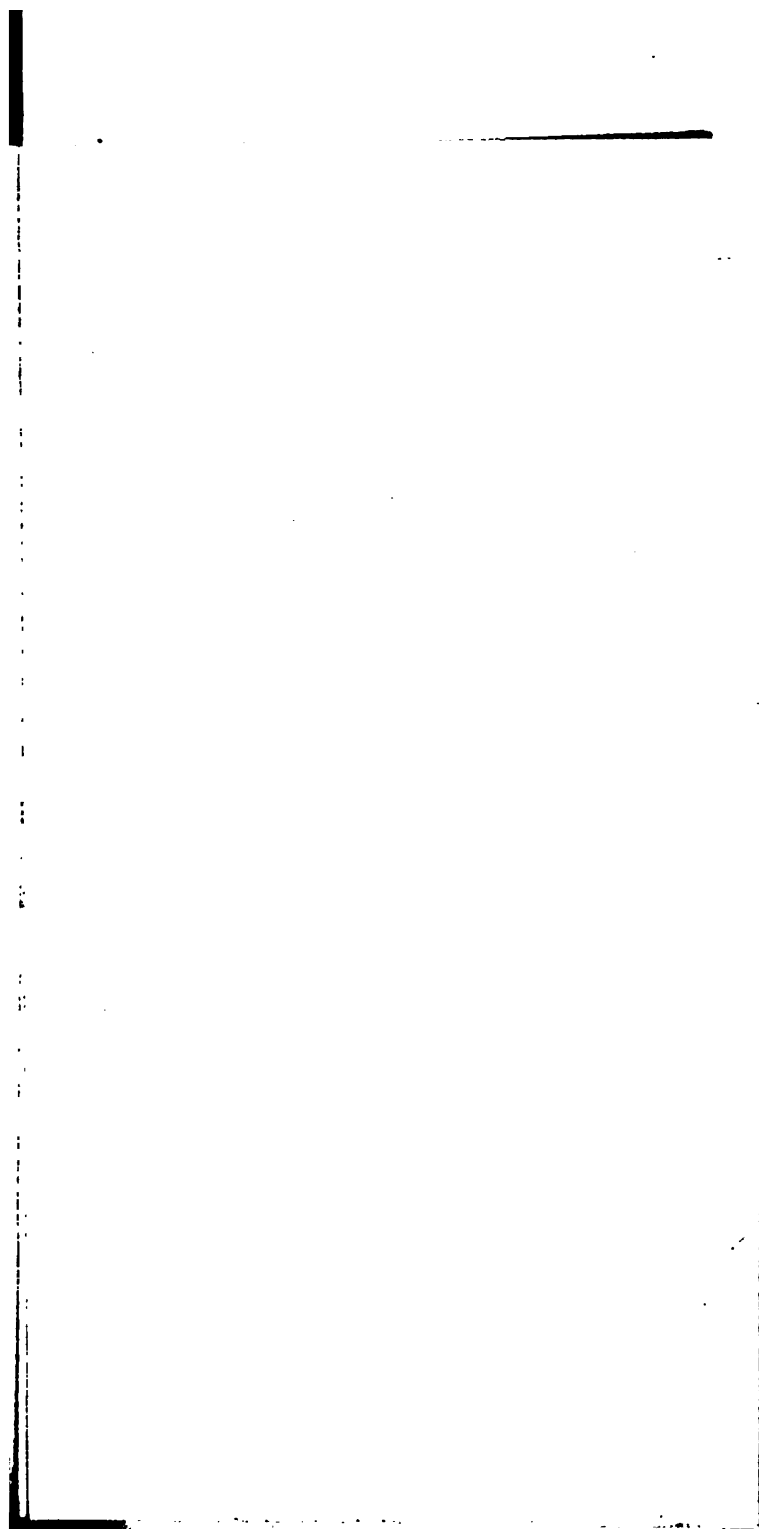


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1903.







1903.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 10.

PALEONTOLOGICAL CONTRIBUTIONS

TO THE

GEOLOGY OF WESTERN AUSTRALIA.

I.

DESCRIPTIONS OF CARBONIFEROUS FOSSILS FROM THE GASCOYNE DISTRICT, WESTERN AUSTRALIA,

BY

R. ETHERIDGE, Junr.,

Curator of the Australian Museum, Sydney, N.S.W.

*Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.*



PERTH:

BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.

1903.



PREFATORY NOTE.

THE Carboniferous rocks of the Gascoyne District form part of a very extensive formation which covers a wide area of country in Western Australia, and which bids fair to become of considerable economic importance.

These rocks have been traced, with a few minor interruptions, across the valleys of the Wooramel, the Murchison, the Greenough as far south as the Irwin River, where coal seams outcrop; and to the northwards across the Minilya, the Henry, the Ashburton, and the Fortescue Rivers. Near the head of this latter river they disappear under the desert, and on emerging cover a wide stretch of country in the Kimberley Division.

In the Gascoyne District the beds consist of sandstones, shales, limestones, and conglomerates. Near the base of the series is a well-marked boulder bed, showing undoubted evidences of glacial origin. The boulder bed is made up of a heterogeneous collection of all varieties of crystalline rocks, together with many very large flat-sided boulders of granite. This bed, which forms a very valuable stratigraphical horizon, has been traced across country for a distance of about 60 miles.

The Carboniferous rocks of the Gascoyne, although arranged in a series of gentle folds, have a prevailing dip to the West. The thickness of the series cannot at present be ascertained, though the bore now being put down at Pelican Hill, near Carnarvon, at the mouth of the Gascoyne, has shown it to be at least 1,600 feet thick.

Fossils are of such importance in determining the relative age, succession, and correlation of strata that the investigation of the Palaeontology of a formation becomes an important factor in the early attempts at the development of the mineral resources of a region in which the stratigraphy has been but imperfectly worked out.

The Geological Survey is indebted to Mr. Robert Etheridge, Junr., Curator of the Australian Museum, Sydney, for assistance rendered gratuitously in the determination and description of

fossils which have been submitted to him from time to time and for the Palæontological Contributions to the Geology of the State, which form the subject matter of this report.

The illustrations by which Mr. Etheridge's descriptions are accompanied are the work of Messrs. F. R. Leggatt and E. R. Waite, and bear evidence of the care which has been bestowed upon them.

On being submitted to the Hon. the Minister for Mines, Mr. Etheridge's report was ordered to be printed for public information.

A. GIBB MAITLAND,
Government Geologist.

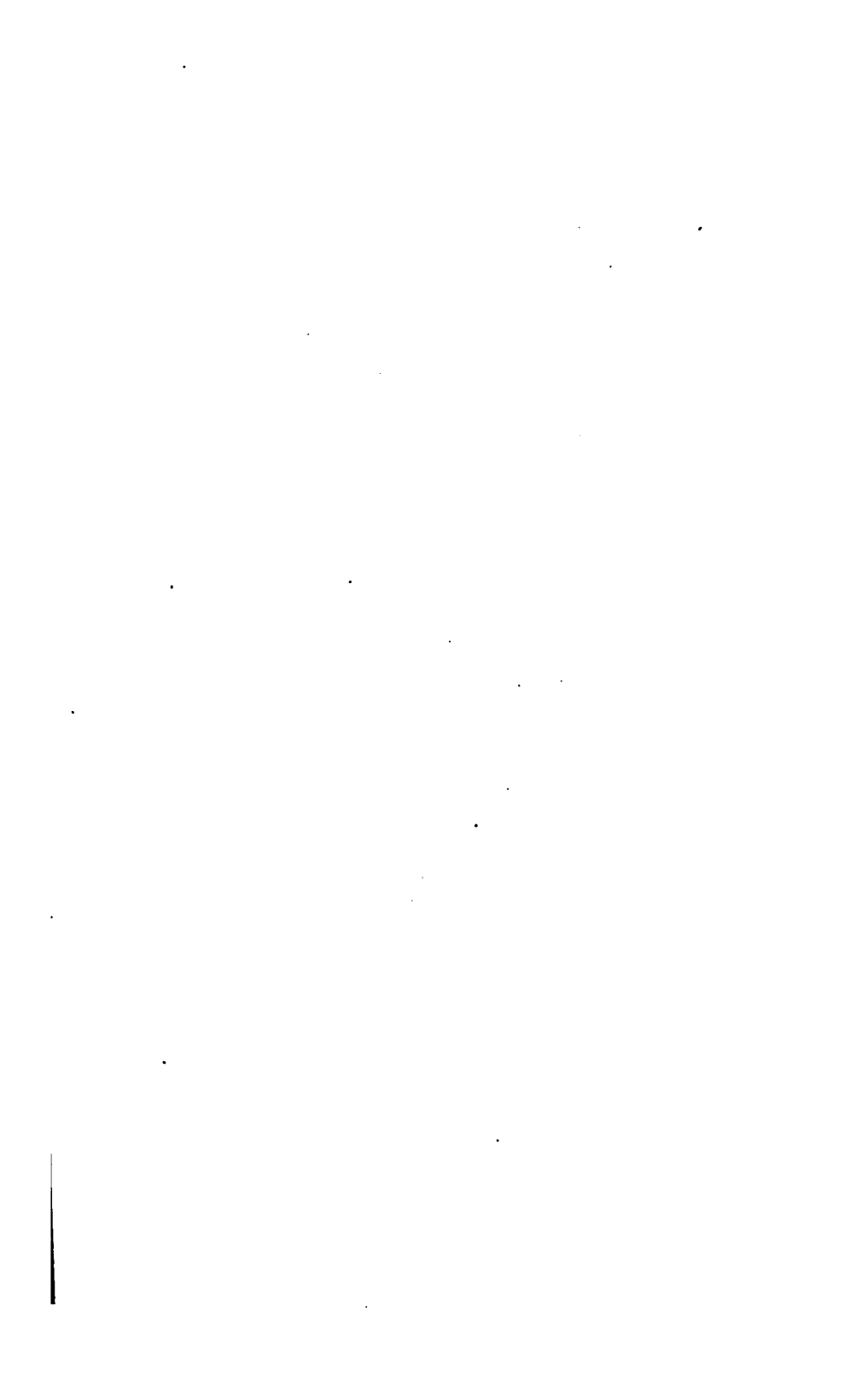
Geological Survey Office,
Beaufort Street,
Perth, 10th July, 1903.

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*Descriptions of Carboniferous Fossils from
the Gascoyne District, Western Australia,
collected by Mr. A. Gibb Maitland, Govern-
ment Geologist,*

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I.—Introduction.

The fossils recorded in the following pages were transmitted to me for description by Mr. A. Gibb Maitland, Government Geologist of Western Australia, and were collected by him and his colleague, Mr. H. W. B. Talbot, Field Assistant.

The following are the localities:—

- (1.) Wandagee Station, Minilya River.
- (2.) Coolkilya Pool, Wandagee Station.
- (3.) Wandagee Hill, Minilya River.
- (4.) Williambury Station, Minilya River.
- (5.) Hills on the Western boundary of No. 4.
- (6.) Well 20, Daurie Creek, Gascoyne River. Shale with microscopic and interesting fragments of Polyzoa.
- (7.) Trig. Station, K. 37, Gascoyne River. Sandstone series.
- (8.) Fossil Hill, Wyndham River, Gascoyne District.
- (9.) Wyndham River. Boulder Bed.
- (10.) Gascoyne River.
- (11.) Baracooda Pool, Arthur River.

The facies of the fossils is purely Carboniferous.

I have added some notes on a most interesting occurrence of Endophytic Fungi, in swollen Crinoid stems, and in the visceral chambers of two species of *Hexagonella*. These specimens have afforded me a far more intimate knowledge of the infesting nature of these peculiar organisms than any previous forms playing the part of "host" that have come under my notice. I wish to take this opportunity to explain the use of the word endophytic. An

endophyte is a plant which grows inside another, and, strictly speaking, the term is not applicable in the present and other instances previously cited by me, from the simple fact that we have a low form of plant life within the tissues and visceral cavities of animals. On the other hand, the term endophytic is a convenient one to express the habit of the intruding organism, and only in this sense is it used by me.

II.—Description of the General Collection.

PLANTÆ.

Obs.—The imperfect specimen represented in Plate I., fig. 1., is possibly the impression of a Furoid, and may be referred to *Chondrites*, Sternberg. From the appearance of the specimen there would seem to have been a central stalk, giving off lateral branches, and the latter short filaments. All that remains is a carbonaceous impression.

Loc.—Wandagee Station, Minilya River.

ACTINOZOA.

GENUS *AMPLEXUS*, J. Sowerby, 1814.

(Mineral Conchol., 1814, i., p. 165).

AMPLEXUS PUSTULOSUS, Hudleston.

Amplexus pustulosus, Hudleston, Quart. Journ. Geol. Soc., 1883, xxxix., p. 591, t. 23, f.l. a-c.

Amplexus pustulosus, Hinde, Geol. Mag., 1893, vii. (3), p. 194.

Obs.—This species is represented in the collection by a portion of a corallum one and three-quarter inches long, and with a compressed diameter of one and a half inches. It is devoid of epitheca, and exhibits the broad flat costæ, two millimetres wide, as in Dr. Hinde's figure, with short septa, two millimetres apart, and wide flat tabulate area. There are, approximately, forty costæ, and externally the septa are represented as flat longitudinal grooves.

Loc.—Williambury Station, Minilya River.

GENUS *PLEUROPHYLLUM*, Hinde, 1890.

(Geol. Mag., 1890, vii. (3), p. 195).

PLEUROPHYLLUM AUSTRALE, Hinde.

Pleurophyllum australe, Hinde, Geol. Mag., 1890, vii. (3), p. 196, t. 8a., f.l. a-f.

Loc.—Williambury Station, Minilya River; Fossil Hill, Wyndham River.

GENUS *HEXAGONELLA*, Waagen and Wentzel, 1886.

(Salt Range Foss. (Pal. Ind.) 1886, i., Pt. 6, p. 911).

HEXAGONELLA DENDROIDEA, Hudleston, *sp.*

Evactinopora dendroidea, Hudleston, Quart. Journ. Geol. Soc., 1883, xxxix, p. 594, t. 23, f. 3 *a-d*.

Hexagonella dendroidea, Waagen and Wentzel, Salt Range Foss. (Pal. Ind.), 1886, i., Pt. 6, p. 913.

Hexagonella dendroidea, Hinde, Geol. Mag., 1890, vii. (3), p. 200, t. 8, f. 6, t. 8a., f. 5 *a-d* (exclude Etheridge's ref.).

Obs.—Hinde remarks that Waagen and Wentzel believed *Hexagonella* to possess "a mode of increase by so-called coenenchymal gemmation," but that he could "find no indication of this alleged coenenchymal growth, but, on the contrary, a mode of growth from a basal lamina." Again, Dr. Hinde adds:—"The centre of the branches has a median lamina extending from end to end, from which the cells are given off. This axial lamina is double in character; in their sections it appears as a dark line with a layer of lighter material on either side of it." From independent examination, I am able to confirm the whole of Hinde's observations, so far as *H. dendroidea* is concerned, as well as the general accuracy of his description of this interesting form. Under these circumstances, it is quite unnecessary to re-describe it.

Loc.—Fossil Hill, Wyndham River.

HEXAGONELLA (?) CRUCIALIS, Hudleston, *sp.*

(Plate III., fig. 1.)

Evactinopora crucialis, Hudleston, Quart. Journ. Geol. Soc., 1883, xxxix., p. 593, t. 23, f. 2 *a-c*.

Evactinopora crucialis, Eth. fil., Proc. Linn. Soc. N. S. Wales, 1889, iv. (2), p. 207.

Obs.—On this fossil, Dr. Hinde remarked:—"It appears to me very doubtful whether the form named *H. (Evactinopora) crucialis*, Hudleston, is really distinct from *H. dendroidea*; as the difference consists merely in the mode of growth, a feature hardly of sufficient importance." I had previously expressed a somewhat similar opinion,* but the examination of additional material has caused me to modify this view. So far, I have never seen on the exterior of *H. (?) crucialis* polygonal spaces bounded by ridges as in *H. dendroidea*, but of course this may only be due to the state of preservation. The internal structure of the two supposed forms is precisely similar, even to the presence of the recumbent cells on a basal lamina in *H. (?) crucialis*. On the other hand, the transverse diameter of the autopenes is less in the latter, being .2 to .24 mm., as against .2 to .25 mm. in *H. dendroidea*. The distance of the

* Proc. Linn. Soc. N. S. Wales, 1889, IV. (2), p. 207

tabulæ apart in the autopores of *H. dendroidea* is less than in *H. (?) crucialis*; in the former it is .5 mm., and in the latter .8mm.

In *H. (?) crucialis* the mode of growth is constantly cruciform, that of the other bifurcate, and therefore presumably branching. Other minor differences can also be detected, such, for instance, as the different sectional outline in the two forms.

H. (?) crucialis is both quadri- and pentaradiate. This cruciform mode of growth is precisely that of *Evactinopora*, M. and W.,* but unfortunately we at present know so little of the internal structure of the American genus that it is unsafe to replace the name *Hexagonella* by that of *Evactinopora*. This step, however, will become necessary if future research should reveal a similar anatomy in the types of the two forms. Messrs. Waagen and Wentzel, the authors of *Hexagonella*, appeared to be very undecided in their opinion at the time they wrote. So far as my present knowledge permits me to judge, I believe the American and Indo-Australian forms will prove to be one and the same generically.

Dr. Hinde credits me, in his synonymy of *H. dendroidea*, with a reference to that species. In my paper on the late Sir W. Macleay's Kimberley fossils, I did not refer to this species, but distinctly to *Evactinopora crucialis*, Hudleston.

Loc.—Fossil Hill, Wyndham River.

ANNELIDA.

GENUS SPIRORBIS, Lamarck, 1818.†

(Hist. Anim. sans Vertèb., 1818, v., p. 358.)

SPIRORBIS AMBIGUUS, Fleming.

(Plate III., fig. 2.)

Spirorbis ambiguus, Fleming, Edinb. Phil. Journ., 1825, xii., p. 246, t. 9, f. 3.

Spirorbis ambiguus, Eth. fl., Geol. Mag., 1880, vii. (2), p. 258, t. 7, f. 9.—11.

Obs.—One example of this little cosmopolitan Tubicolar Annelid is present adhering to a valve of *Oliothryis macleayana*, Eth. fl. I believe this to be the first record of a Carboniferous *Spirorbis* in Australia, unless the specimen mentioned by Dr. G. J. Hinde as *S. omphalodes*, Goldf.‡ be it. The horizon given by the latter is Devonian, and the locality Gascoyne River, from whence I have never seen other than Carboniferous fossils.

The present shell is dextral, with an open umbilicus, and the aperture, although a little broken, seems to have been produced. The sculpture is not retained.

Loc.—Fossil Hill, Wyndham River.

* Meek and Worthen, Proc. Acad. Nat. Sci. Philadel., 1865, p. 165; Illinois Geol. Survey Report, 1868, III., Pt. 2, p. 501. † Eth. fl. restricted 1890. Geol. Mag., 1880, vii. (2) pp. 112 and 258. ‡ Geol. Mag., 1880, vii. (3), p. 189.

CRUSTACEAN (?) TRACKS.

Obs.—Plate I., fig. 2, is probably only a fragment of a very much larger specimen. It consists of nine nodular or sub-moniliform bodies separated by transverse depressions, the whole forming a carved body five inches in length. The under surface is simply rounded, whilst on both the convex and concave faces is a continuous projecting ridge; the nodules are three-eighths of an inch long by five-eighths wide. It is simply a cast in sandy, slightly micaceous shale, without the slightest trace of test or organic covering.

Much speculation and a good deal of controversy has at times taken place as to the real nature of what are generally known as "tracks and markings." In the present instance, however, a tolerably satisfactory explanation can be given. Almost identical tracks were described* by Mr. Albany Hancock from the Carboniferous sandstones of the North of England. He remarked:—"Full-sized specimens are half an inch wide, and are composed of a series of nodules . . . , which give them an articulated appearance. The nodules, which vary a little in size, are usually about half an inch long, and are not very symmetrically or regularly formed; consequently the surface has generally an imperfect or worn character."

Mr. Hancock offered the following explanation:—"Whilst walking on the beach sand at Cullercoats, Northumberland (Engl.), he observed a flat, ribbon-like track, occasionally several feet in length, winding in an intricate manner, and frequently and irregularly convoluted, "forming, as it were, loose knots or systems in which neither the commencement nor the termination can be easily detected The tracks also occasionally show enlargements placed at some little distance from each other."† On watching, he says that the sand at one of the extremities was observed to be gently agitated; and on this agitation ceasing, the track was found to have added nearly half an inch to its length. "In the course of two or three minutes the sand was again put in motion, and the track once more a little prolonged. These movements were repeated over and over again, until it was quite clear that the tracks were formed by slow, intermitting steps, and not, as might have been supposed, by one continuous gliding motion. Having satisfied myself of this, I took up the morsel of sand at the end of the track, just as it was again becoming agitated, and found that I had captured a small crustacean. . . . It was undoubtedly one of the Amphipoda."‡ He further adds that whilst forming its track the animal is never seen. The Crustacean thus captured was subsequently described by Mr. C. Spence Bate as *Kroyera arenaria*. A second form was also taken at the same time, named by Mr. Bate *Sulcator arenarius*. When the latter was "placed in a shallow vessel with the bottom thickly covered with sand moistened with sea-water, so as to resemble as nearly as possible the state of the beach . . . it thrust itself through the

* Ann. Mag. Nat. Hist., 1858, ii. (3), p. 448, t. 16, 17. † Ann. Mag. Nat. Hist., 1858, ii. (3), p. 448.
 ‡ Ann. Mag. Nat. Hist., 1858, ii. (3), p. 446.

surface of the sand, and, sinking immediately again, left there an oval swelling; and repeating the action five or six times formed a series of nodules, which, if continued, would have produced a track of a peculiar articulated appearance." *

Mr. Hancock's article is well worth the perusal of those interested in the formation of tracks, and, without wishing to imply that the track now under consideration was formed by an Amphipod, of which, so far as I know, no trace has been found in the West Australian Carboniferous beds, yet the resemblance to the tracks of the two species named is so marked that the possibility exists; at any rate the identity of the track now figured with those from the North of England Carboniferous cannot be gainsaid. In the words of Mr. Hancock, "It may, therefore, be assumed that the animal which made these nodulous tracks, like our little crustaceans, pushed along in its path step by step, resting awhile after each advance; but that, instead of moving in the same horizontal plane, it alternately rose and sank a little; consequently a series of nodules were produced, and the track acquired its peculiar articulated appearance." † An alternative suggestion was to the effect that these tracks might be the runs of Trilobites. It would be quite possible to offer other explanations, but at present our knowledge of these obscure markings is so circumscribed that little out of the realm of speculation can be advanced.

Loc.—Coolkilya Pool, Wandagee Station, Minilya River.

BRACHIOPODA.

GENUS SPIRIFERA, *J. Sowerby*, 1816.

(*Mineral Conchol.*, 1816, ii, p. 41.)

SPIRIFERA MUSAKHEYLENSIS, *Davidson*.

Spirifera Moosakhailensis, Davidson, Quart. Journ. Geol. Soc., 1862, p. 28, t. 2, f. 2 a-c.

Spirifer Moosakhailensis, De Koninck, Mém. Soc. Sci. Liege, 1863, xviii.

Spirifer Moosakhailensis, Beyrich, Abhandl. K. Akad. Wiss. Berlin, 1864 (1865), xxxvi., p. 77, t. 1, f. 7.

Spirifera Moosakhailensis, Davidson, Quart. Journ. Geol. Soc., 1866, xxii., p. 41, t. 2, f. 6.

Spirifera Moosakhailensis, Eth., fil., Cat. Austr. Foss., 1878, p. 57.

Spirifer timorensis, Martin, Samml. Geol. Reichs-Mus. Leiden, 1881, i. (1), p. 41, f. 7, 7a and b, 8.

Spirifera Musakheylensis, Waagen, Salt Range Foss. (Pal. Ind.), 1883, i., Fas. 4, No. 2, p. 512, t. 45.

* Ann. Mag. Nat. Hist., 1858, ii. (3), p. 447.

† Ann. Mag. Nat. Hist., 1858, ii. (3), p. 450.

Spirifera Musakheylensis, var. *australis*, Foord, Geol. Mag., 1890, vii. (3), p. 147, t. 7, f. 2, ?t. 5, f. 12.

Spirifer fasciger, Schellwien, Palaeontographica, 1892, xxxix., Lief. 1, p. 42, t. 5, f. 3 (non f. 2).

Spirifer Musakheylensis, Rothpletz, Palaeontographica, 1892, xxxix., Lief. 2 and 3, p. 79, t. 9, f. 1 and 2.

Spirifer Musakhleyensis, Deiner, Himalayan Foss. (Pal. Ind.) 1897, i., Pt. 3, p. 43, t. 6, f. 8; *Ibid.* Pt. 4, p. 35, t. 3, f. 3 and 4, t. 4, f. 1a and b and 2, t. 5, f. 1; *Ibid.* 1899, Pt. 2, p. 63, t. 5, f. 3-7.

[Compare—

Spirifer fasciger, Keyserling, Reise in das Petschoraland, 1843, p. 229, t. 8, f. 3, 3a, b.

Spirifer tegulatus, Trautschold, Kalkbrüche von Mjatschkowa, 1876, Pt. 2, p. 80, t. 8, f. 6 a-g.

Spirifer fasciger, Tschernyschew, Mém. Com. Géol. Russ., 1889, iii., Pt. 4, p. 366, t. 5, f. 4a-c.]

Obs.—I have examined several specimens of this widely-distributed species, and although adopting Davidson's specific name, I cannot divest myself of the belief that Keyserling's *S. fasciger* and Trautschold's *S. tegulatus* are identical. At the same time, it would be presumptuous on my part to pit my opinion one way or the other against that of those with opportunities of examining examples of all the so-called species. Whether the views of Messrs. Tschernyschew, Nitikin* and Schellwien† on the one hand, or those of Messrs. Waagen and Diener on the other, be correct, can only be settled by assembling a large series of all the various forms for comparison, and in particular a comparison of the internal characters. Whether or no *S. tegulatus* be identical with Davidson's species, will not cause any alteration in nomenclature, for this name was not proposed until some years after the former, but in the event of *S. fasciger* being found identical, Davidson's name must be relegated to the synonymic list.

The prominence of the fasciculi of costæ, and the number of costæ comprised in a fasciculus is open to great variation in our Australian shells, even in specimens from the same locality. The degree of preservation of the "sharp, projecting, concentric, undulating laminæ" (frills would be a better term), is also very variable. In one specimen before me the fasciculi are not only very prominent and angular, but the concentric frills are more prominent and upstanding on the cardinal half of the valve than they are on the fore, or ventral half, where they become more strictly of the nature of laminæ. Again, our shells developed few and wide-apart lati-laminæ, as in some of the Indian example of the species.

* Mém. Com. Géol. Russ., 1890, v., No. 5, p. 164. † Zeits. Deuts. Geol. Gesellschaft, 1894, xvi., 1 Heft, p. 72.

All the specimens both of this and the following species are, with one exception, ventral valves. The latter is a small individual imbedded in matrix, but from its outline appears to be *S. musakhleyensis*. In this the area is proportionately narrow, and without subdivision, concave and denticulated, and oblique to the general plane of the valve. The delthyrium is wide, with well-marked deltidial grooves. The dental sockets are triangular and without grooves, extending backwards to the cardinal process or boss; the latter is somewhat flattened and vertically grooved.

Loc.—Fossil Hill, Wyndham River.

SPIRIFERA HARDMANI, Foord.

(Plate I., figs. 6 & 7; Plate II., figs. 7-9.)

Spirifera Hardmani, Foord, Geol. Mag., 1890, VII. (8), p. 146, t. 7, f. 1, 1a.

Obs.—I believe I have before me several specimens of the *Spirifer* described under this name by Mr. Foord, but whether it is a stable species is open to doubt. The ill-defined folds of the lateral rounded areas of the ventral valve, described by Foord, are quite recognisable, and are suspiciously like some of the fasciculate bundles of costæ in *S. musakhleyensis*. There exists, however, it may be a very trivial but at the same time well-marked difference in the surface characters of the two shells. In the present form, the lati-laminæ commence close to the umbo and rapidly succeed one another, becoming closer and closer as the front of the valve is approached, and on crossing the sulcus the lati-laminæ take a sharp V-shaped dip forwards. In Davidson's species, judging from Waagen and Diener's figures, the lati-laminæ are variable in position and distance apart, and on crossing the sulcus form a very open and wide V-shaped figure. The surface of *S. Hardmani*, when well preserved, is very delicately frilled, the frills pressed on the surfaces of the lati-laminæ.

The area is moderately wide and without subdivision, concave transversely (i.e., at a right angle to the plane of the valve), lined or stepped to correspond with the lati-laminæ, and over all longitudinally striated. The delthyrium is large and widely triangular, with well-marked deltarial grooves and prominent, stout teeth.

Mr. Foord suggests a reference to this species of that portion of a shell figured by me from Queensland as *S. trigonalis* var. *crassa*, De Kon. (?).^{*} He may be correct, but the specimen is in too bad a state of preservation to enable one to arrive at a satisfactory conclusion.

Loc.—Fossil Hill, Wyndham River.

^{*} Geol. Pal. Q'land, 1892, p. 230, t. 11, f. 5.

SPIRIFERA LATA, McCoy.?

(Plate I., fig. 8.)

Spirifera lata, McCoy, Ann. Mag. Nat. Hist., 1847, xx., p. 233, t. 13, f. 7.

Spirifer latus, De Koninck, Rech. Pal. Foss. Nouv.-Galles du Sud, 1877, Pt. 3, p. 106.

Spirifera lata, Eth. fil., Cat. Austr. Foss., 1878, p. 56.

Spirifera lata, Foord, Geol. Mag., 1890, vii. (3), p. 145, t. 6.

Obs.—McCoy described and figured this species from an internal cast, in which the ventral sulcus and alar angles were devoid of costæ. Mr. Foord copied McCoy's description, but figured a fine slab of valves in different stages of preservation. Some unquestionably display the sulcus devoid of ribs, others are not so definite, as the sulci appear to be occupied by one or more costæ. I now figure a ventral valve which may be that of *S. lata*, although I apply the name with reluctance, differing from that species by a costate sinus, but at the same time with the extended and nearly smooth alations, otherwise characteristic of it. The costæ are crossed by fine, delicate, flat, concentric frills, like those of the *S. mucronata* group. The area is moderately wide, and gently concave at right angles to the general plane of the valve.

I believe this to be a variety of *S. lata*, McCoy. The latter is a very rare form in the Carboniferous and Permo-Carboniferous rocks of Eastern Australia. It appears to be a close ally of *S. alata*, Schl., a Permian species, also occurring in the Indian Salt Range Series, and devoid of costæ on the wings.

The more or less spindle-shaped outline also places this shell near *S. convoluta*, Phill., but in the latter both the wings and sulcus are costate, although the latter not to the same extent as in the specimen now provisionally referred to *S. lata*.

Loc.—Fossil Hill, Wyndham River.

SPIRIFERA, *sp. ind.*

(Plate I., fig. 9; Plate II., fig. 6.)

Obs.—A single dorsal valve of an alate *Spirifer* accompanies the last specimen. It possesses numerous gently convex, entire regular costæ, not united into bundles or fasciculi of any kind, but fading away on the wings, although not to the same extent as in *S. alata*, and crossed by close concentric lines.

The area is moderately wide and vertical—i.e. in the same plane as the valve. The cardinal process is large, round, and vertically striate; the cardinal sockets long, groove-like above, and expanded at their outer terminations; the crural bases sharp, upstanding, and separated from the cardinal process by deep grooves (the deltidial grooves) running alongside the dental sockets, and their downward and forward extensions much thickened. There is no trace of

denticles along the area; the cavity of the muscular impressions is deep and narrow.

This valve has some points of close resemblance to the alate varieties of *S. Lydekkeri*, Diener,* but the material at my disposal is of too limited a nature to enable me to institute a close comparison. I must, however, dissent from Mr. Diener's opinion that his species resembles our Permo-Carboniferous *S. Clarkei*, De Kon. It appears to me that the two are much more widely separated than he supposes.

Loc.—Gascoyne River.

GENUS RETICULARIA, *McCoy*, 1844.

(Synop. Carb. Lime. Foss. Ireland, 1844, p. 142.)

RETICULARIA LINEATA, *Martin*, *sp.*

Spirifera lineata (Martin), Davidson, Mon. Brit. Carb. Brach., 1858, Pt. 5, p. 62, t. 13, f. 1–13.

Reticularia lineata, Foord, Geol. Mag., 1890, vii. (3), p. 153.

Obs.—Mr. Foord recorded this widely distributed shell from the Irwin River. Mr. Maitland collected examples of the ventral valve from the locality given below, displaying the principal features of the species.

Loc.—Fossil Hill, Wyndham River.

GENUS CLEIOTHYRIS, *King*, 1850.†

(Mon. Perm. Foss. England, 1850, p. 137.)

CLEIOTHYRIS MACLEAYANA, *Eth. fil. sp.*

(Plate III., figs. 10–20.)

Athyris macleayana, *Eth. fil.*, Proc. Linn. Soc. N.S. Wales, 1889, iv. (2), p. 208, t. 17, f. 1–5.

Athyris macleayana, Foord, Geol. Mag., 1890, vii. (3), p. 149, t. 7, f. 3, p. 150, f. B & C (*non f.A.*).

Obs.—A very fine series of this interesting shell was obtained by Mr. Maitland at two localities.

The suspicion originally expressed by me that the concentric laminæ of the exterior extended into free spines, as in *Cleiothyris Roysii*, Lev., *sp.*, was confirmed by Mr. Foord, and the shell is, therefore, removed to that genus. Some of the specimens now before me exhibit this feature much more distinctly than did those in the Macleay collection, and even when the surface is worn the spines can often be detected along the immediate edges of the laminæ; they are occasionally very much thickened in the pedicle valve. In a few instances the transversely oval outline gives place to a longitudinally oval one, and much variability is also observable in the degree of convexity of the dorsal or brachial valve.

* Himalayan Foss. (Pal. Ind.), 1897, I., Pt. 2, t. 3, f. 1, 7, 8. † Non Phillips, 1841.

Mr. Foord figured the interior of the ventral valve, and I have several specimens before me equally well preserved. I have not seen bidd teeth, but the most perfect individual displays the teeth hooked or recurved, as in *Athyris* proper. The hinge plate of the brachial valve is thick, and the internal opening of the visceral foramen large, but the median lobe of the hinge plate does not seem to have been extended forwards; the bases of the crura were thick and solid. The degree of depth of the adductor scars in the pedicle valve and their extension forwards are subject to much variability, and in consequence the septum separating the adductor impressions is also variable in length. In very few specimens is the septum as well marked as in Foord's Fig. C, and in all interiors examined by me the diductor (cardinal) impressions are much wider, or more oval, than shown in the same illustration, although they always terminate below in lobes, as described by Foord.

In the brachial or dorsal valve the united adductors form a long oval scar, the anterior pair somewhat leaf-shaped, the posterior rather sagittate, with the dual points forward, and a strong intervening septum; the vascular markings cover the remainder of the interior surface.

Loc.—Fossil Hill, Wyndham River; Hills on the west boundary of Williambury Station, Minilya River, Gascoyne River.

CLEIOTHYRIS MACLEAYANA, VAR. *BARACOODENSIS* var. nov.

(Plate III., figs. 5-9.)

(?) *Athyris macleayana*, Foord, Geol. Mag., 1890, vii. (3), p. 150, f. A. (non figs. B & C).

Obs.—At the undermentioned locality a well-marked variety of *C. macleayana* occurs to the exclusion of the typical form of the species. The convexity of the pedicle valve of the variety is relatively greater, the appearance on the latter of an incipient sinus, and the much greater transverse width of both valves are features that at once separate it from the species in chief. The valves to some extent lose the characteristic ovate-triangular outline of *C. macleayana*, but all other characters are the same. One of Mr. Foord's figures of the latter resembles it to some extent, and may possibly be identical.

Loc.—Baracooda Pool, Arthur River.

GENUS *SEMINULA*, McCoy, 1844.

(Synop. Carb. Lime. Foss. Ireland, 1844, p. 158.)

SEMINULA, sp. ind.

(Plate I., fig. 5; Plate III., fig. 21.)

Obs.—A single example of the united valves, not wholly free from matrix, may be referred to this genus. The valves are bi-convex, elongately oval in form, the ventral with a slight median

sinus, and an over-curved umbo, which I believe was perforate. It displays rough *lati-laminæ*, and the test was impunctate. It conveys to the eye a shell of the *Seminula subtilita*, Hall, sp. type, rather than that of either the *S. ambigua* Sby. sp., or *S. trinuclea*, Hall, sp. groups.

Loc.—Baracooda Pool, Arthur River.

GENUS ORTHOTETES, *Fischer de Waldheim*, 1829.

(Bull. Soc. Imp. Nat. Moscou, 1829, p. 375.)

ORTHOTETES CRENISTRIA, *Phillips*, sp.

Streptorhynchus crenistria (Phill., sp.), Davidson, Mon. Brit. Carb. Brach., Pt. 4, 1861, p. 124, t. 26, t. 27, f. 1.

Orthotetes crenistria, Eth. fil., Cat. Austr. Foss., 1878, p. 50.

Orthotetes crenistria, Foord, Geol. Mag., 1890, vii. (3), p. 154.

Obs.—Two portions, one that of a dorsal valve, of this cosmopolitan species, are present associated with *Productus tenuistriatus*, De Vern. (?). Foord records it from the Irwin River, Victoria District.

Loc.—Fossil Hill, Wyndham River.

GENUS PRODUCTUS, *J. Sowerby*, 1814.

(Mineral Conchol., 1814, i., p. 153.)

PRODUCTUS SEMIRETICULATUS, *Martin*, sp.

(Plate II., figs. 3-5.)

Productus semireticulatus (Martin, sp.), Davidson, Mon. Brit. Carb. Brach., Pt. 4, 1861, p. 149, t. 43, t. 44, f. 1-4.

Productus semireticulatus, Beyrich, Abhandl. K. Akad. Wissensch. Berlin, 1865, xxxvi., p. 82, t. 2, f. 1, 2a-c.

Productus semireticulatus, Meek, Final Report U.S. Geol. Survey Nebraska, Pt. 2, 1872, p. 160, t. 5, f. 7a and b.

Productus semireticulatus, Meek, Report U.S. Geol. Explor. 40th Par. (King's), 1877, iv., Pt. 1, p. 69, t. 7, f. 5.

Productus semireticulatus, Eth. fil., Cat. Austr. Foss., 1878, p. 53.

Productus semireticulatus, Kayser, Richthofen's China, Pt. 8, 1883, p. 181, t. 25, f. 1-4.

Productus semireticulatus, Waagen, Salt Range Foss. (Pal. Ind.), 1884, i., Pt. 4, Fas. 4, p. 679, p. 680, f. a. & c.

Productus semireticulatus, Diener, Himalayan Foss. (Pal. Ind.), 1897, i., Pt. 3, p. 18, t. 2, f. 1, 3, 5, t. 3, f. 1 & 2.

Obs.—I think there can be very little doubt that the shells represented in Plate II., figs. 3-5, are forms of this widely-distributed species. I am acquainted with four specimens in various conditions

of preservation. They belong to the transversely oval variety represented by Davidson's Plate 43, figs. 1 and 2, with the hinge line practically as wide as the shell, the visceral region of the ventral valve well vaulted and traversed by a sinus rather wider than is usually seen in this species; the auriculate expansions largely developed, the costæ rather coarse, bearing spine bases both on the body of the shell and the wings. The decussation of the visceral regions both in the dorsal and ventral valves of the West Australian *Producti* is remarkably pronounced, resembling an illustration of this species given by De Koninck.* They approach generally to the Himalayan form figured by Diener, both in outline, costation, and decussation, but the costæ in the latter are more plentifully supplied with broken spine bases.

Mr. E. Schellwien† has described a variety of this well-known species as var. *bathykolpos* from the Alpine Fusulina Limestone, in which the ventral sinus is wider, deeper, and more pronounced than is usually the case, indicating a strong alliance with our form.

Loc.—Williambury Station, Minilya River; Baracooda Pool, Arthur River; and Gascoyne River.

The specimens from the first and second localities were collected by Mr. Maitland, and the third was presented by him to the Mining and Geological Museum, Sydney.

PRODUCTUS TENUISTRATUS, De Verneuil. (?)

VAR. *FOORDI, var. nov.*

(Plate I., figs. 3 and 4; Plate III., fig. 22).

Productus tenuistratus (De Vern.), Foord, Geol. Mag., 1890, vii. (3), p. 151, t. 7, f. 4, 4a.

Obs.—A small *Productus* from the Irwin River was referred by Mr. Foord to the above species, a Russian Carboniferous form. I have before me what I believe to be the same shell, represented by numerous specimens from Fossil Hill. I have grave doubts of the wisdom of this determination, of course presuming Mr. Foord's shells and mine to be specifically identical, for the very characters on which the latter relies to unite the West Australian and Russian forms seem to me to separate them.

A glance at De Verneuil's figure ‡ will indicate how remarkably the, almost microscopically so, are the costal striæ when compared with the much coarser sculpture represented by Mr. Foord's figures. In support of his determination, the latter quotes a figure of Mr. T. Tchernyschew's § representing De Verneuil's species. If the recent Russian Palæontologist's determination is correct, then his figures bridge over the interval between De Verneuil and Foord's illustrations. Even the former are more in accord with Foord's than with De Verneuil's, and differ from the last-named precisely as Foord's

* Mon. Genres *Productus* et *Chonetes*, 1847, t. 9, f. 1 d and e. † Palæontographica, vol. xxix., Lief. 1, t. 2, f. 4-10. ‡ Murchison's Geol. Russia in Europe, 1845, ii., p. 260, t. 1, f. 6. § Mém. Com. Géol. Russie, 1899, iii., No. 4, p. 372, t. 6, f. 15 a-c.

do. Were it not that the costation in *P. Neffidievi*, De Vern,* another Russian species, is more regular, I would be inclined to regard it as a nearer ally of the West Australian form than *P. tenuistriatus*.

The *Producti* from Fossil Hill are of the *P. cora* type in outline, with an inflated visceral region high above the cardinal margin, but without overhanging the latter, and small alar expansions, with occasional transverse plications. The costæ of the ventral valve vary very much; they are threadlike without being absolutely fine, direct or flexuous, occasionally irregular, entire or bifurcate, the forking taking place at about half the length of the shell, and separated by intercostal spaces as wide as the costæ are thick, or wider; the interpolated costæ soon acquire the same thickness as the parent ones. There are no spine bases or tubercles on the body of the ventral valve, but at times a few may be seen immediately below the cardinal margin. I do not think any of my specimens exhibit the true outer shell layer; they all appear to be more or less exfoliated, and, from the appearance of the figure, I imagine Mr. Foord's specimen was also. The ventral valve is evenly rounded, without the slightest sign of a sinus.

If the spine bases, scattered over the surface of *P. lineatus*, Waagent, be omitted from consideration, the West Australian *Productus* bears a suspiciously close resemblance to it, more particularly the small variety figured under this name by Diener.†

A number of other described species might be compared, did space permit. Amongst these may be mentioned *P. hemispherium*, Kutorga, figured by Mr. G. von Arthaber‡, possessing a similarly fine sculpture. This is again seen in *P. lævicostus*, White,|| but the outline is too triangular for the present shell.

In view of the doubt expressed in the opening paragraph of the identity of the shell with De Verneuil's Russian species, I propose to distinguish it in the meantime by the varietal name, *Foordi*.

Loc.—Fossil Hill, Wyndham River.

GENUS STROPHALOSIA, King, 1844.

(Ann. Mag. Nat. Hist., 1844, xiv., p. 313.)

STROPHALOSIA, *sp. ind.*

(Plate I., figs. 10-12.)

(?) *Strophalosia Clarkei*, Foord, Geol. Mag., 1890, vii. (3), p. 103, t. 5, f. 7, 7a, 8.

Obs.—A small *Strophalosia*, uniform in size throughout the suite of specimens, but unfortunately they are all more or less

* Murchison's Geol. Russia in Europe, 1845, ii., p. 259, t. 18, f. 2. † Salt Range Foss. (Pal. Ind.), 1884, i., Pt. 4, Fas. 4, p. 673, t. 66, f. la., 2d. ‡ Himalayan Foss. (Pal. Ind.), 1897, i., Pt. 3, t. 4, f. 2a and 5d. § Beitrage Pal. Oster-Ungarns, 1900, xii., Heft. 4, p. 256, t. 20, f. 4, band c. This must not be confounded with the much older *P. hemispherium*, Sby. || Hall and Whitfield, Rep. U.S. Geol. Explor. 40th Parallel (King's) 1877, iv., Pt. 2, p. 266, t. 5, f. 7 & 8.

embedded in matrix. They are, I believe, identical with those referred by Mr. Foord to *S. Clarkei*, Etheridge. None of the specimens exhibit the external shelly layer, but, as Mr. Foord says of his fossils, have a "silky appearance," and are pitted, not punctate, I think. In the absence of satisfactory material, I hardly feel justified in attaching a specific name, and at the same time feel indisposed to regard either these gathered by Mr. Maitland, or those from the Fitzroy River described by Mr. Foord, as *S. Clarkei*, and for the following reasons:—

- (1.) The uniformly small size of the specimens as compared with that of typical examples from Queensland and New South Wales localities;
- (2.) The much less convexity of outline in the ventral valve;
- (3.) The depressed umbonal region of the ventral valve, hardly rising above the level of the cardinal margin;
- (4.) Extreme concavity of the dorsal valve;
- (5.) Shorter septum in the dorsal valve;
- (6.) Comparatively wider reniform impressions in the same valve.

On the other hand, the cardinal margin is long as in *S. Clarkei*, thus opposed to this character in the other Australian species, *S. Gerardi*, King, and *S. Jukesii*, mihi, from both of which the Western Australian form also differs in the absence of spines. Had these existed some trace would have been left, notwithstanding the loss of the outer shelly layer. The impression conveyed to my mind by Mr. Foord's figures, and the specimens before me is that of a fourth Australian species not previously recognised. The following characters can be gleaned from the specimens:—The outline was transversely sub-oval; the lateral and ventral margins regularly rounded; the ventral valve gently and regularly convex without being vaulted, and without sinus, a straight cardinal margin barely as wide as the valve, with a well marked area for its size, but above which the umbonal region barely rises. There are small but well-defined alar expansions, particularly internally; there is a narrow linear deltidium, and the teeth, although small, are prominent and projecting. The dorsal valve concave exteriorly, but internally flat, with strongly bevelled margins; the area somewhat narrow, and pyriform diverging dental sockets.

There is no trace of spines either on the surface of the ventral valve, nor along the cardinal margin.

Loc.—Coolkilya Pool, Wandagee Station, Minilya River.

GENUS AULOSTEGES, *Helmersen*, 1847.

(Bull., Acad. Sci. St. Petersburg, 1847, vi., p. 135.)

AULOSTEGES BARACOODENSIS, *sp. nov.*

(Plate II., figs. 1-2a.)

Sp. Char.—Shell large, rotundo-quadrate, longer than wide, concavo-convex, the convexity of low degree; cardinal margins much shorter than the greatest width of the shell; auricles not highly developed, coincident with the curvature of the valves; cardinal angles obtusely rounded, neither quadrangular nor emarginate; lateral and ventral margins rounded, the latter faintly insinuated centrally. Ventral or pedicle valve more or less convex, but not inflated, and with a faint sinus; umbonal region high, the umbo blunt and barely overturned; area high, approximately from half to one-third the width of the cardinal margin, transversely lined but not distorted; delthyrium high and linear; deltidium very narrow, annulate but not spined or twisted. Brachial or dorsal valve concave; cardinal area linear; cardinal process small and spike-like externally; septum rather strong and showing through the test, extending for two-thirds the length of the valve. Sculpture in both valves of concentric latilaminæ, thickly set with scattered tubular spines, arising from irregularly developed low costæ; spines when broken or worn leaving perforated tubercles.

Obs.—This remarkably fine species I believe to be an *Aulosteges* rather than a *Strophalosia*. Cardinal teeth have not been observed, nor is there any trace of umbonal attachment; moreover, the deltidium partakes much more of that of the former than the latter genus, and does not quite extend to the actual cardinal margin. Again, the linear cardinal area of the brachial valve is not exposed exteriorly as in *Strophalosia*.

I have seen two specimens, one collected by Mr. Maitland, forming a part of the present series, and another presented by Mr. J. Connelly, Junr., to the Mining and Geological Museum. The length of these shells varies from two and three-quarter inches to three and a-quarter inches, and the breadth is the same.

A. baracoodensis exceeds the type of the genus, *A. Wangenheimi*, De Vern.* many times in size and possesses an area that does not extend the whole length of the cardinal margin. It is, however, to two of the Indian Salt Range species that *A. baracoodensis* approaches nearest, viz.:—*A. medlicottianus* Waagen† and *A. Dalhousi*, Davidson,‡ but again it exceeds both in size. As regards the first of these two species, the less elevated area and form of sculpture also separates it from *A. baracoodensis*. The second Indian species possesses a similar high pedicle area, elevated umbonal region, and straight delthyrium to the like parts in the West Australian form,

* *Orthis*, Murchison's Geol. Russia in Europe, 1845, ii., p. 194, t. 11, f. 5a and b; *Aulosteges*, Davidson, Brit. Foss. Brach. 1853, i. (Introd.), p. 116, t. 9, f. 212-215; id., Geinitz, Dyas, 1861, p. 95, t. 17, f. 20, a-f. † Salt Range Fossils (Pal. Ind.), 1884, i., Pt. 4, p. 683, t. 62. ‡ Quart. Journ. Geol. Soc., 1882, xviii., p. 33, t. 2, f. 7a and b; Waagen, Salt Range Foss. (Pal. Ind.), 1884, i., Pt. 4, p. 662, t. 63, f. 1 a-c.

but the area extends the whole length of the cardinal margin, and the alar expansions are different. There is a third Indian species, *A. tibeticus* Diener * resembling *A. Dalhousi*, but very much larger. On the whole, *A. baracoodensis* is more nearly allied to Davidson's shell than to any other.

Loc.—Baracooda Pool, Arthur River. The specimen in the Mining and Geological Museum, Sydney, is from the Wooramel River (*Pres. J. Connelly, Junr.*).

GENUS CHONETES, Fischer, 1837.

(Oryctographie Gouv. Moscou, 1837, p. 134.)

CHONETES PRATTI, Davidson.

Chonetes Prattii, Davidson, Geologist, 1859, p. 116, t. 4, f. 9-12.

Chonetes Prattii, Bullen Newton, Geol. Mag. 1892, ix. (3), p. 542, t. 14.

Obs.—Numerous specimens in various stages of preservation are displayed on two hand-specimens of highly fossiliferous shale, and illustrate most of the characters described by Messrs. Davidson and Newton.

From the second and third localities recorded below are a few other less well preserved examples of a *Chonetes*, with the outward appearance of *C. Prattii*; in all probability they are this species also.

Loc.—Fossil Hill, Wyndham River; (?) Wandagee Station; and Wandagee Hill, Minilya River.

PELECYPODA.

GENUS AVICULOPECTEN, McCoy, 1851.

(Ann. Mag. Nat. Hist., 1851, vii. (2), p. 171.)

AVICULOPECTEN TENUICOLLIS, Dana, sp.

(Plate III., figs. 3 and 4.)

Pecten tenuicollis, Dana, Am. Journ. Sci., 1847, iv. (2), p. 160.

Pecten tenuicollis, Dana, Wilkes U.S. Explor. Exped., 1849, x. Geol., p. 705, t. 9, f. 7.

Aviculopecten tenuicollis, Eth. fil., Cat. Austr. Foss., 1878, p. 67.

Aviculopecten tenuicollis, Eth. fil., Proc. Linn. Soc. N.S. Wales, 1889, iv. (2), p. 203.

Aviculopecten tenuicollis, Foord, Geol. Mag., 1890, vii. (3), p. 103, t. 5, f. 9.

Sp. Char.—Shell of medium size, suborbicular, nearly equilateral, length and breadth about equal. Right (?) valve gently convex, spreading towards the front, contracted towards the umbo;

* Himalaya Foss. (Pal. Ind.), 1897, i. Pt. 3, p. 35 and 5, f. 3-6.

the ventral margin semicircular, cardinal margin straight, less than the width of the valve; umbo acute; anterior and posterior slopes abrupt and steep. Auricles apparently nearly equal, flat, triangular, one bears three radiating costæ, the other appears plain. Costæ numerous, 20-26 (?), radially curved, entire, rounded, coarse, separated by flat intercostal spaces each bearing a secondary interpolated rib, but not reaching to the umbo, the whole crossed by very fine, close, flat, frill-like laminæ, rendering the primary costæ (at any rate) slightly spinose towards the front of the valve.

Obs.—There are three mutilated specimens from one locality, and a fairly well preserved valve from a second place that enable me to give a slightly emended description to that drawn up from previously examined Kimberley material. Confirmation is also afforded of my previous description of fine concentric frill sculpture, which is well shown on one of the mutilated specimens.

Loc.—Boulder bed, Wyndham River, Lyons District (valve); Wandagee Station, Minilya River.

GASTEROPODA.

GENUS *PTYCHOMPHALINA* (Bayle), Fischer, 1885.

(*Man. Conchyl. et Pal. Conchyl.*, Fas. 9, 1885, p. 850.)

PTYCHOMPHALINA MAITLANDI, *sp. nov.*

(Plate I., figs. 13-15.)

Sp. Char.—Shell of moderate size, conical, short, stout, of four of five whorls: body whorl obtusely angular, convex below, flat and obliquely inclined, or a little concave above: posterior whorls rounded, tightly embracing, sutures simple and close. Band well marked, placed on the angle of the body whorl, but immediately super-sutural on the others, and defined by two fine keels, with the intermediate band surface slightly concave. Mouth oval and rather oblique: inner lip slightly reflected, and separated from the base of the body-whorl by a fine, simple groove. Sculpture consisting of very fine regular oblique direct lines on the posterior whorls, forming retral curves to and from the band on the body-whorl with a slight tendency to become sigmoidal on the base: neither spiral lines nor granules.

Obs.—A short stout shell, the outline more nearly approaching that of a *Gosseletina* rather than that of *Ptychomphalina*.

In defining *Ptychomphalina*, De Koninck (as *Ptychomphalus*, De Kon., non L. Ag.) simply states that the band is visible on all the whorls, without assigning to it any particular position, but I find from his figures that it is almost, if not always, sutural on the posterior whorls, and more or less median on the body-whorl.

In some respects *P. Maitlandi* is not unlike the poorly preserved "*Pleurotomaria*?" figured by Foord* from the King Leopold Ranges, but I hardly think the two are identical.

* *Geol. Mag.*, 1880, vii. (3), p. 104, t. 4, f. 10, 10a.

The angularity of the body-whorl distinguishes it from a badly preserved Pleurotomarid I figured* from Treachery Bay, Port Darwin, and provisionally referred to *Mourlonia humilis*, De Kon., sp.

Loc.—Wandagee Station, Minilya River.

III.—An Endophytic Fungus infesting Enlarged Crinoid Stems.

In 1879 I published a paper, "Observations on the Swollen Condition of Carboniferous Crinoid Stems," † in which I referred to the already known information on the subject, including the remarks of David Ure, Schlotheim, Miller, the Messrs. Austin, Eofe, and others, and described a series of enlarged stems from the Carboniferous Systems of England and Scotland. I showed that the enlargement or distortion was caused—

- (1.) By an effort on the part of the Crinoid to repair damages caused by the loss of a cirrus;
- (2.) By the abnormal secretion of stereom over extraneous attached foreign bodies, such as corals, stems of smaller Crinoids, encrusting Polyzoa and adherent Brachiopoda;
- (3.) By the attack of supposed boring parasites.

In 1884 my late friend, Dr. P. H. Carpenter,‡ stated that abnormal growths of the calcareous tissue of the arms of some of the Comatulæ and Pentacrinidæ, dredged by the Challenger Expedition, were due to one of the Bristle Worms (*Myzostoma*), but similar enlargements were not found on the stems. At the same time he expressed the opinion, held in common with Professor J. Von Graff, that certain swollen stems of *Millericrinus*, figured by De Loriol from the Jurassic rocks of France and Switzerland were due to cystiferous enlargements caused by *Myzostoma*. Later Dr. Von Graff published § an interesting account of the ravages of *Myzostoma* proper in recent and fossil Crinoids. He considered that, amongst other things, many of the swollen stems met with in the fossil state are due to this worm.

Mr. F. A. Bather, contributed a few remarks on this subject in his "Crinoidea of Gothland." Of the stem of *Botryocrinus ramosissimus*, Ang., he remarked:—"The stem is always slightly swollen above the cirri. This swelling was perhaps induced by the attacks of boring parasites, of which there are traces: the middle

* Contrib. Pal. S. Austr., S.A. Parl. Papers, 1897, No. 127, p. 15, t. 1, f. 11.
 Proc. Nat. Hist. Soc. Glasgow, 1879, iv., p. 19. † Challenger Report, Zool., xi., p. 134.
 § Palæontographica, 1885, xxxi., p. 185.

of the stem also shows numerous small pittings, irregular in disposition, which are probably the work of parasites." * Again, in the distal part of the stem of *Gissocrinus incurvatus* Ang. sp. "there is considerable irregularity, and the ossicles are broken up by longitudinal or oblique sutures. Whether this is a pathological or senile development, or whether it is an original structure, is uncertain." † This irregularity is well exhibited in some of the present specimens.

Another remarkable instance of this cyst-like growth is figured by Messrs. Wachsmuth and Springer on two cirri apparently of *Batocrinus grandis*. They say ‡—"Similar cysts are frequently found along the stem, but have not before been found to occur on the cirri. They resemble the Myzostoma cysts which occur along the arms of recent Comatulæ, and like them were evidently caused by parasites." Similar cysts are shown on two arms of an example of *Agaricocrinus inflatus* Hall, § and parasitic growths on an unnamed radial plate and on the base of a *Platycrinus*, || etc., all these might perhaps give rise to such irritation as to cause increased deposition of stereom, and ultimately become enlargements. P. de Loriol figures other excellent examples of cystoid expansions amongst Secondary Crinoidea. Swellings are shown on the stems of *Millericrinus granulatus*, Etallon, ¶ from the Kelloway and Oxfordian beds of the Oolite, and *Millericrinus*, sp. ** from the Corallian; these are some of the most striking enlargements I have seen.

The foregoing references are introduced with the view of indicating some of the principal causes of cystoid swellings amongst the Crinoidea. I now purpose describing some stem enlargements infected with an organism of a totally different nature, an endophytic fungoid growth. Plate IV., figs. 1-6, illustrate the outward form of the stems previous to cutting for the preparation of microscopic sections, and on the same plate, Figs. 7-9, are given some of the more characteristic appearances of the intruding body, slightly magnified, very carefully executed by my colleague, Mr. Edgar R. Waite.

Plate IV., fig. 1, illustrates portion of a column with an open cicatrix, somewhat quadrangular in outline, the stem wall impressed around the edges of the opening, and the columnals deformed; enlargement has taken place more on one side than the other. The cicatrix closely resembles one previously figured †† by me from the British Carboniferous, the cause of secretion of stereom being apparently an *Archæopora*; on slicing this stem it became evident that penetration had extended inwards but a very short distance.

A microscopic section reveals the fact that the shallow excavation and the crevices leading from it are filled with an olive, or

* Loc. cit. 1893, Pt. 1, p. 120, t. 6, f. 174-176. † Ibid. p. 170, t. 10, f. 347. ‡ N. American Crinoidea Camerata, 1897, i., p. 43, t. 1, f. 2. § Wachsmuth and Springer, Loc. cit., p. 502, p. 39, f. 7. || Wachsmuth and Springer, Loc. cit. t. 4, f. 18-20. ¶ Pal. Franç. Terr. Juras., Crinoidea, 1883, Pt. 1, Feuil. 16-18, t. 63, f. 2, 4, 5, 6, 7, 8, 9, 22, etc. ** Ibid. 1884, Pt. 1, Feuil. 25-27, t. 99, f. 2, 2a, 4, 4a. †† Proc. Nat. Hist. Soc. Glasgow, 1879, iv., t. 1, f. 16 and 17.

sherry-yellow, flocculent-looking material, with here and there irregularly shaped brown to black pigment masses, and scattered round black bodies. The flocculent matter also more or less permeates the surrounding stereom, and is continued along the joints between the columnals, even to the axial canal. There are also a series of similarly affected parallel longitudinal zones extending through the columnals. The black pigment masses are either homogeneously so, or when at all broken up or with frayed edges, are seen to be composed of groups of spherical bodies exactly resembling the spores of *Palaeoperone endophytica*, mihi, or the heterospores of *Palaeopede Whiteleggei*, mihi. The scattered, round black bodies are of a similar nature, and are either single, or united in twos or threes by a stolon; they are not confined to the flocculent matter but are to be found in the substance of the stereom itself.

In Plate IV., fig. 2, the column is slightly enlarged, with a, to all intents and purposes, closed cicatrix, and the columnals again deflected from their normal position. On slicing, however, the fact is revealed that the original opening led into a chamber between the outer wall and the axial canal, subsequently closed by a deposition of stereom. One of my previous figures * resembles this, except that the closed cavity communicates with the axial canal.

We find by means of a microscopic section that the T-shaped (in section) cavity is filled with fragments of clear calcite, and the cracks between these lined with the flocculent deposit, the pigment masses, and scattered spores. The stereom immediately above and below the chamber is densely packed with the pigment masses and scattered spores, the former assuming a more or less arborescent appearance. The whole of the axial canal comprised within the section is attacked, particularly with scattered spores.

Plate IV., fig. 3, represents an irregularly enlarged stem which seems to have been attacked in two places. Above is a small cicatrix evinced by a depression, and the usual disorganisation of the columnals. Below is the second swelling, without any trace of a cicatrix at all, but exhibiting two columnals greatly increased in width at the expense of the others, whose growth appears to have been entirely stayed. On slicing this specimen the other cicatrix was found to lead into a very shallow, as it may be termed, subcutaneous cavity having much the appearance of a true *Myzostoma* tube. Within the lower enlargement is a more or less quadrangular cavity surrounding the axial canal.

The microscopic section shows that this latter cavity is filled with clear calcite, flocculent matter, and clusters of black and yellow spores.

Plate IV., fig. 4, is a bilateral symmetrically enlarged stem with several cicatrices, more or less closed, and with much disturbance of the columnals. In this instance nearly the whole of the

* Proc. Nat. Hist. Soc. Glasgow, 1879, IV., t. 1, f. 8.

interior of the stem is affected, both along the axial canal and the stereom intervening between the latter and the new enclosing layer forming the exterior. One well marked opening is presented with the edges rounded inwards, not caused by attrition, but by a regular semi-circular deposition of new stereom by the Crinoid in its endeavour to close the aperture. The lower lip of the aperture is fractured inwards, and leads into a large irregular-shaped space occupying nearly the whole interior of the column-portion, from a thin exterior shell of stereom back to and inclusive of the axial canal. The whole of this space is intensely affected with dense black patches of pigment matter, breaking up into connected tube-like branches, and finally into scattered separate spores. Wherever traversed by the intruding body the stereom in this column is much altered.

An unsymmetrically enlarged, more or less barrel-shaped stem portion is represented in Plate IV., fig. 5. There was evidently great disorganisation of the columnals, as in fig. 2, but the cicatrix is externally hidden by an encrusting growth of Polyzoa. On slicing no tube was cut, but an internal digitate cavity revealed under the convexity presented by the front of the figure, and near the axial canal. In the superimposed hump of stereom the columnal sutures are obliterated in the section. A general idea of this cavity, except that it is not double, may be gained from one of Von Graaf's figures,* which he ascribes to *Myzostoma*. The infilling of this cavity is of a white colour, and does not microscopically present any features of interest.

Plate IV., fig. 6, is a barrel-shaped enlargement, with only the faintest trace of a cicatrix; but there is a similar broadening out of some of the columnals at the expense of others, as seen in figs. 3, 4, and 5. On slicing, a large triangular cavity becomes evident, extending back to and connected with the axial canal. It is filled with a dark ochreous-brown deposit. The whole axial canal is affected and filled with a similar material. A microscopic section reveals the fact that this ochreous in-filling, both in the cavity and axial canal, consists of highly discoloured secondary stereom, containing broken-up patches of the olive-yellow flocculent material, a few masses of the dark pigment matter, and a large number of scattered spores of a lighter colour than usual.

That the intruding body set up considerable irritation in the tissues of these Crinoid stems, I think there can be very little doubt; but whether or no it was the primary cause is open to question. No distinct evidence exists of the nature of the original intruder; possibly it was similar to one or other of the agents described elsewhere. It is hardly feasible that the fungoid growth prepared the openings; more likely that its spores penetrated the already open passages, and propagated there, so completing what the original intruder had commenced.

* Palaeontographica, 1885, xxxi., t. 16, f. 4.

Taking the whole of the sections together, the endophytic growth occurs in one or other of the following conditions:—

- (1.) Olive-brown to sherry-yellow flocculent matter, very plentiful, and penetrating the stereom in all directions, and may result from the ultimate disintegration of No. 2.
- (2.) Amorphous masses of pigment matter varying in colour from deep amber brown to dense black, frequently dissolving wholly or more particularly around the edges into Nos. 4, 5, and 8.
- (3.) Sub-dendritic masses of this pigment matter, with indistinct traces of No. 5.
- (4.) Small bone-lacunæ-like masses of No. 2, usually of a much lighter colour.
- (5.) Irregularly-shaped clusters of distinctly formed globular bodies (? oospores) varying in colour from sherry-yellow to dense black, often resembling a series of tubers united by stolons or stoloniferous roots, dissolving into No. 6.
- (6.) The globular bodies (? oospores) in moniliform sequence, but without any trace of stoloniferous union.
- (7.) The same bodies often lying contiguous to one another in pairs.
- (8.) The same bodies scattered singly in the stereom and varying very much in size.

The structures above described are in many ways suggestive of *Thallophytes* allied to those described by the late Professor P. M. Duncan as *Palæachlya perforans*,* and *Achlyites penetrans*,† and the following by myself—*Palæachlya tortuosa*,‡ *P. torquis*,§ *Palæoperone endophytica*,|| and *Palæopede*¶ *Whiteleggei*. The olive, sherry-yellow, or amber flocculent matter, black pigment masses and globular bodies, etc., have been seen in all, but in no instance in the Crinoid stem-portions have I detected tortuous tubes like those of *Achlya perforans*, *P. tortuosa*, or *P. torquis*, pin-like tubes similar to those of *Palæoperone endophytica*, nor stoloniferous chains of moniliform cells and heterospores as in the alga *Palæopede Whiteleggei*. The flocculent matter, which accompanies most of these organisms distributed through the surrounding tissues of the host is seen in the visceral chambers of the *Favosites* containing *Palæachlya torquis*, just as it does the stereom of the Crinoid stems, and in the visceral chambers of *Stenopora crinita* containing the pin-tubes of *Palæoperone endophytica*.

* Quart. Journ. Geol. Soc., 1876, xxxii, p. 210. † Achlya, Proc. R. Soc. 1876, xxv, No. 174, p. 252. ‡ Rec. Geol. Survey N.S. Wales, 1891, ii., No. 3, p. 96. § Rec. Austr. Mus., 1899, iii., No. 5, p. 126. || Rec. Geol. Survey N. S. Wales, 1891, iii., No. 3, p. 2. ¶ Rec. Austr. Mus., 1899, iii., No. 5, p. 127.

In the Crinoid stem-portions the dark pigment masses are of irregular outline, but also line any chance cavity, just as Duncan describes similar lines in the tubes of *Palæachlya perforans*,* often, however, assuming a bone-lacunæ-like to sub-dendritic appearance. In the former state the pigment masses are precisely similar to those observed by Duncan in a Tasmanian *Thamnastræa*. He speaks of the tubes "frequently merged into an irregular dark mass and resembled the tubuli of bone (Haversian canals) passing into lacunæ."† In some of my sections again, these lacunæ-like patches are of a peculiar pale vermilion tint, not unlike the infilling of some of the *Palæachlya* tubes in *Calceola*, of a "reddish tint," also noticed by Duncan.‡

In the absence of any tubular structure I think it will be more satisfactory to refer this form to the Genus *Achlyites*, as used by Dr. A. Meschinelli.§

The Crinoid stems were collected by Mr. Maitland at William-bury Station, Minilya River.

IV.—Palæoperone Infesting the Visceral Chambers of Hexagonella.

The visceral chambers of both corals *Hexagonella dendroidea* and *H. (?) crucialis* are infested with a fungoid growth, in some of its characters quite in keeping with that already described in the Crinoid stem-portions. In addition, however, are clusters of minute tubes, reminding one of those of *Palæoperone endophytica*. Both the autopores and mesopores are occupied by this growth, but the former most so, and it is more copious in *H. dendroidea* than *H. (?) crucialis*. The various phases assumed are as follows:—

(1.) A copious development of the olive to sherry-yellow flocculent matter containing minute brown grains, and here and there faint, although decided, bifurcating filaments running through it (? mycelium). In the autopores, cracks in the infilling calcite are also penetrated by this substance.

(2.) Tubes parallel or sub-radiate, having a diameter of about .04 mm., either transverse to or parallel to the growth of the autopore visceral chambers (Plate V., fig. 1). These are either filled or partially filled with the flocculent matter in various stages of density, from translucent to opaque, and even passing into the black pigment condition, or they may be empty, but surrounded by the flocculent matter (Plate V., fig. 1). I have not observed an instance of the enlargement of one of the tubes into a loculus at one end.

*Quart. Journ. Geol. Soc., 1876, xxxii., p. 208. †Quart. Journ. Geol. Soc., 1876, xxxii., p. 208. ‡Quart. Journ. Geol. Soc., 1876, xxxii., p. 209. §Fungorum Foss. Omnium, 1886, p. 10.

(3.) Amorphous or irregular patches of dense brown to black pigment matter, breaking up round the edges into globular spores (? oospores) (Plate V., figs. 4 and 5). This material either clings round the periphery of a visceral chamber (Plate V., fig. 4) or completely fills an autopore and its adjoining mesopores, and in some cases these contiguous masses seem to have become one, and the intervening wall tissues destroyed. Indeed, there are some circular openings with a diameter of one millimetre distributed throughout the corallum occupied by the pigment matters that cannot be explained other than by this hypothesis.

(4.) Detached globular spores (? oospores), varying in size, with an average diameter of .02 mm., black, brown, or even red, either singly (Plate V., fig. 3), in clusters (Plate V., figs. 4, 5), united in pairs (Plate V., fig. 3), or forming sub-dendroid masses (plate V., fig. 8), or apparently arranged in linear series (Plate V., figs. 6, 7).

(5.) In one particular section three of these spores are to be seen attached to the ends of the tubes more or less after the manner of *Palæoperone endophytica* (Plate V., fig. 2).

It may be noted that the tubes in question do not penetrate the tissues of these corals like those of some species of *Palæachlya*, but are simply resting tubes similar to those of *Palæoperone*. For this reason the endophyte of *Hexagonella* is referred provisionally to that genus.

In conclusion I would like to point out that in some of Waagen and Wentzel's figures of *Hexagonella*, from the Salt Range, the corallites contain black spots and patches, closely resembling the appearance of the endophytic form under description. These may be only patches of matrix, on the other hand, they may be of the nature of *Palæoperone*. I make this suggestion for what it may be worth; it is, however, significant, as I have elsewhere pointed out, that the corallite tissues of another Salt Range species *Geinitzella columnaris*, Schl., sp.,* do unquestionably exhibit penetrating tubes similar to those of *Palæachlya penetrans*, and *P. torquis*. The *Hexagonella* referred to is *H. ramosa*, W. & W. †

I am indebted to my colleague, Mr. T. Whitelegge for the various measurements of these minute organisms.

* Salt Range Foss. (Pal. Ind.) 1886, i. Pt. 6, t. 115, f. 1.

† Ibid, t. 106, f. 3 and 4.







PLATE I.

CHONDRITES, *sp.*

- 1.—Portion of shale with impressions of a *Chondrites*-like plant.

CRUSTACEAN (?) TRACK.

- 2.—Moniliform or beaded track in sandy shale, possibly that of a Crustacean.

PRODUCTUS TENUISTRIATUS, *De Vern (?)*, var. *FOORDI*, *Eth. fl.*

- 3.—Ventral valve with costae.
4.—Ventral valve more or less decorticated with small alar expansions.

SEMINULA, *sp. ind.*

- 5.—Ventral valve with laminae of growth.

SPIRIFERA HARDMANI, *Foord.*

- 6.—Ventral valve showing area, etc.
7.—Another and stouter specimen. The smaller valve I am inclined to refer to *S. musakhleyensis*, *Dav.*

SPIRIFERA LATA, *McCoy (?)*.

- 8.—A ventral valve, probably a variety of this species.

SPIRIFERA, *sp. ind.*

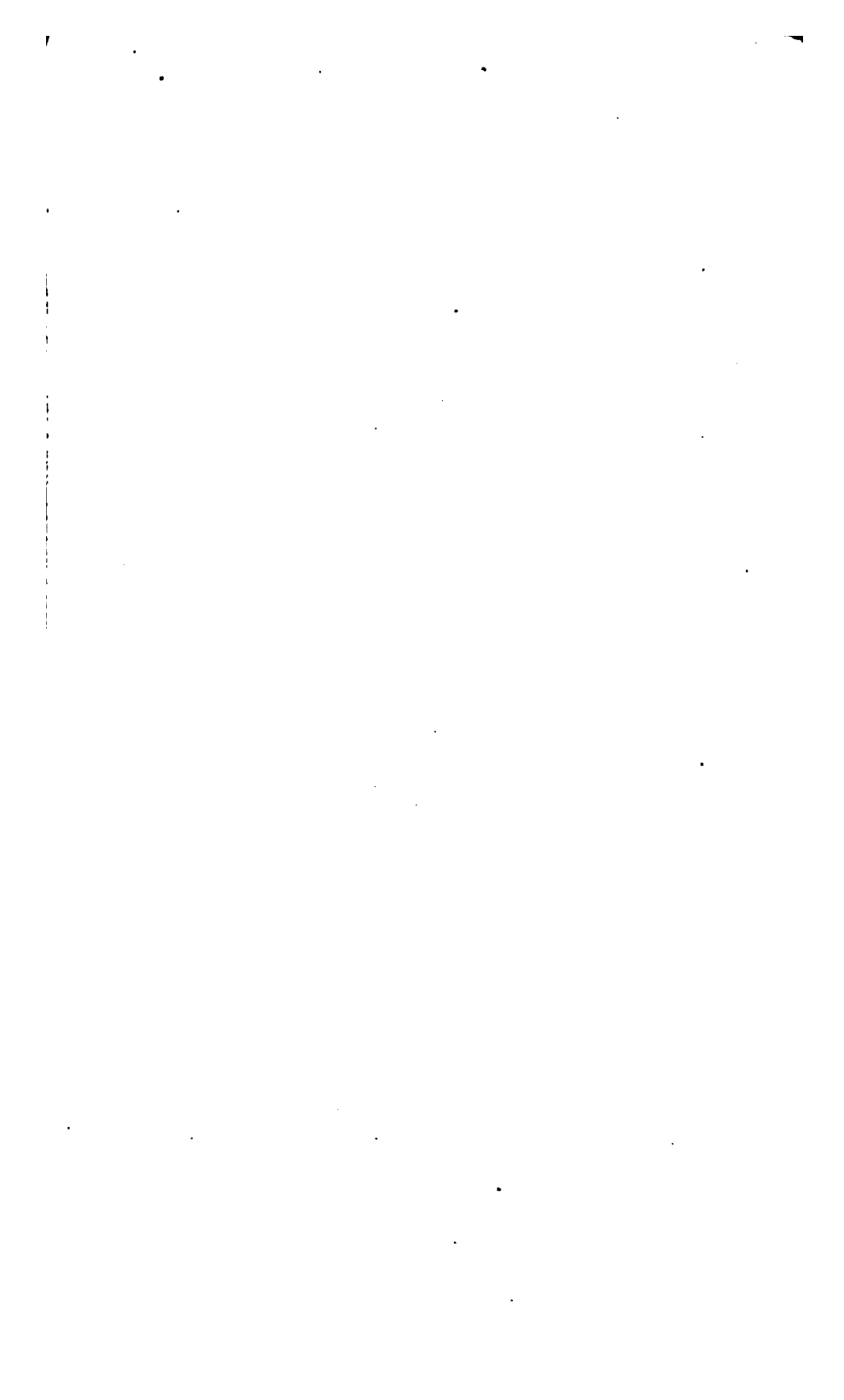
- 9.—Dorsal valve of an alate *Spirifer*.

STROPHALOSIA, *sp. ind.*

- 10.—A ventral valve exfoliated, possessing a silky appearance.
11.—Interior of a ventral valve, exhibiting the area, narrow deltidium and teeth.
12.—Interior of a dorsal valve, displaying the dental sockets.

PTYCHOMPHALINA MAITLANDI, *Eth. fl.*

- 13.—View of a medium-sized specimen, exhibiting five whorls sculpture, and band.
14.—A larger but imperfect individual displaying the mouth.
15.—A portion of the band of Fig. 13, enlarged.



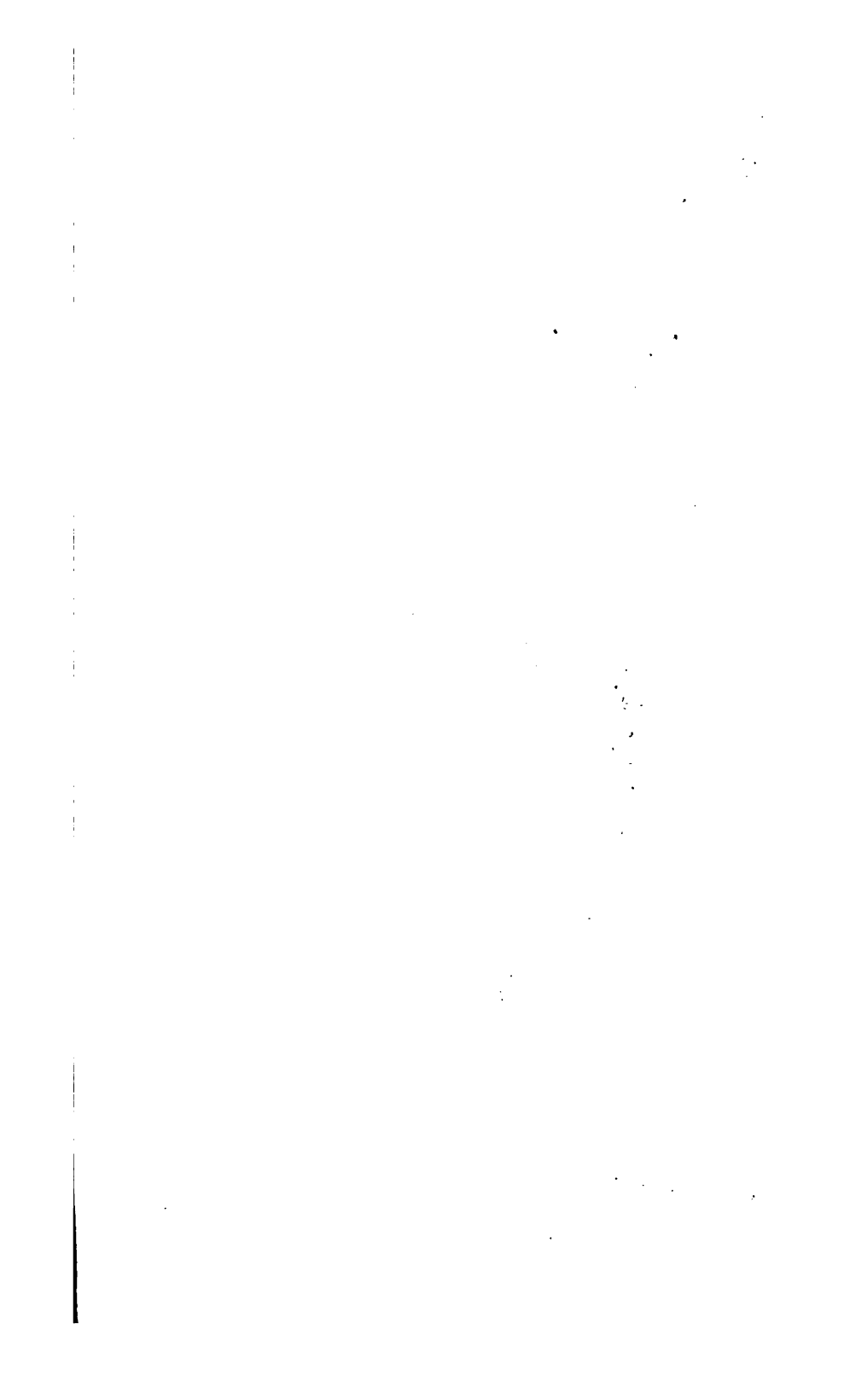




PLATE II.

AULOSTEGES BARACOODENSIS, Eth. fl.

- Fig. 1.—Ventral valve, showing the concentric latilaminæ and scattered broken spine bases.
 „ 2.—The dorsal valve and ventral area with its narrow annulate deltidium.
 „ 2a.—The deltidium enlarged.

PRODUCTUS SEMIRETICULATUS, Martin, sp.

- „ 3.—Portion of a worn ventral valve.
 „ 4.—Dorsal view of the same specimen. (Fig. 3.)
 „ 5.—Side view of the same. (Fig. 3.)

SPIRIFERA, sp. ind.

- „ 6.—Interior of the dorsal valve, Pl. 1, Fig. 9.

SPIRIFERA HARDMANI, Foord.

- „ 7.—Ventral valve; exterior view of Pl. 1, Fig. 6.
 „ 8.—Ventral valve; exterior view of Pl. 1, Fig. 7.
 „ 9.—Ventral valve, exhibiting the V-shaped latilaminæ.

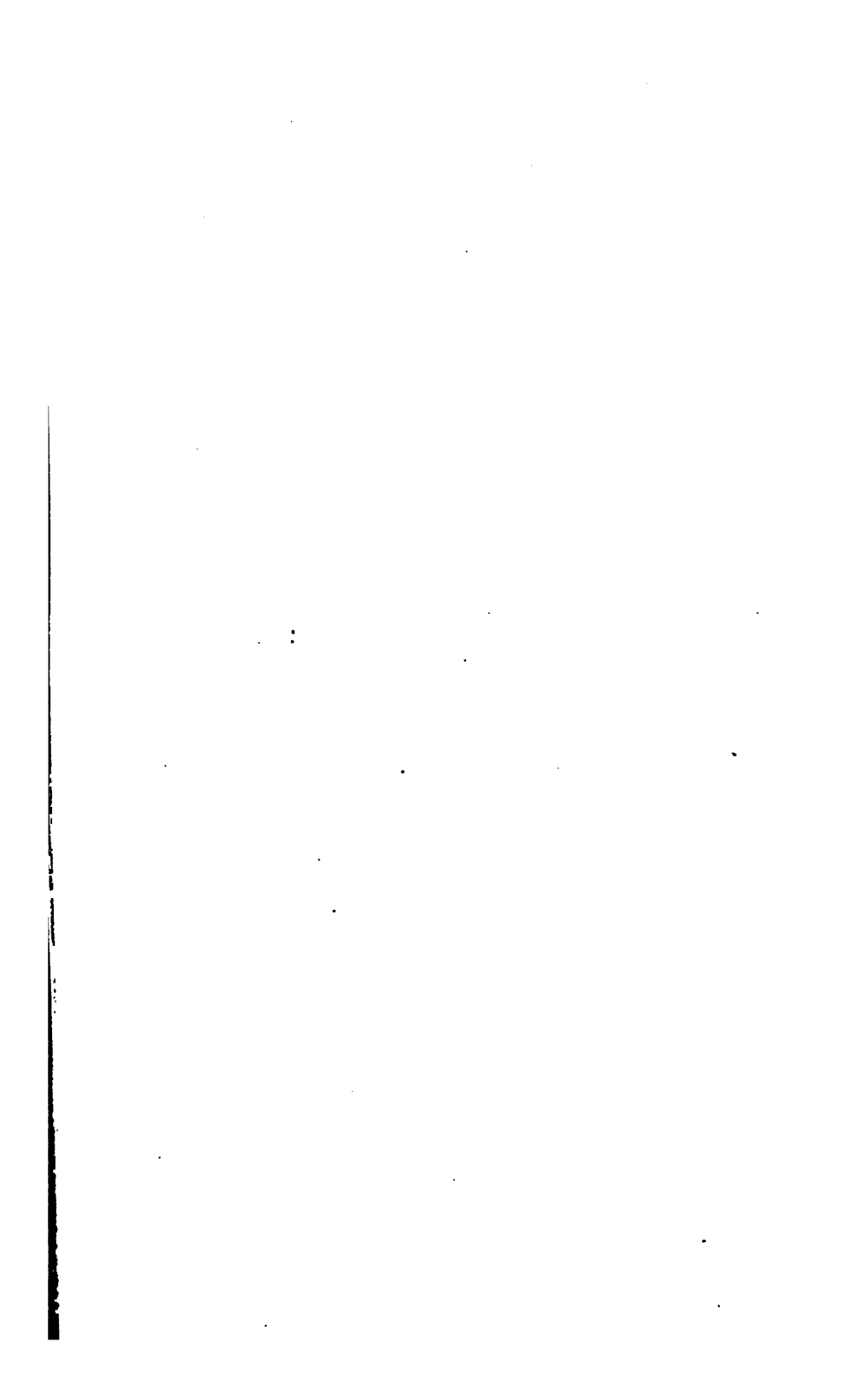




PLATE III.

HEXAGONELLA (?) CRUCIALIS, *Hudleston, sp.*

- 1.—Portion of a four-rayed somewhat weathered corallum.

SPIROBIS AMBIGUUS, *Fleming*

- 2.—A tube adhering to a valve of *Cleiothyris macleayana*.

AVICULOPECTEN TENUICOLLIS, *Dana*.

- 3.—A more or less complete valve, displaying the radiating costæ, and transverse imbricating laminae.
4.—Portion of a smaller valve showing the interpolated ribs and imbricating laminae.

CLEIOTHYRIS MACLEAYANA, var. BARACOODENSIS, *Eth. fl.*

- 5.—View of the dorsal valve, showing outline
6.—Ventral valve and portion of another.
7.—Dorsal valve with remains of sculpture.
8.—The united valves, the nearly flat ventral above.
9.—The same specimen (Figs. 5 and 8) seen from the side.

CLEIOTHYRIS MACLEAYANA *Eth. fl.*

- 10.—A slightly concave ventral valve.
11.—Dorsal valve with a portion of the test worn away, showing a part of one of the spiral cones.
12.—An almost flat ventral valve.
13.—Ventral valve with the concentric spinose laminae well shown.
14.—Interior of the same valve (Fig. 13).
15.—Interior of another ventral valve.
15a.—Side view of a portion of Fig. 15, displaying the hooked teeth.
16.—The conjoined valves seen from the front, the convex dorsal above.
17.—The conjoined valves (Fig. 16) seen from the cardinal aspect, the flat ventral above.
18.—Conjoined valves of a much flattened individual, the flat ventral above.
19.—Interior of the dorsal valve.
20.—Spine bases protruding from the concentric shell laminae enlarged.

SEMINULA, *sp. ind.*

- 21.—Side view of the united valves (Pl. 1, Fig. 5).

PRODUCTUS TENUISTRIATUS, *De Vern, var. FOORDI, Eth. fl.*

- 22.—Ventral valve showing slight alar extremities to the cardinal margin.



6.



1.



PLATE IV.

ENLARGED CRINOID STEM-PORTIONS.

- Fig. 1.—An open cicatrix, somewhat quadrangular in outline, and deformed columnals.
- . 2.—A slightly enlarged stem-portion, a closed cicatrix, and the sutures of the columnals greatly deflected from their normal course.
 - . 3.—An irregularly enlarged stem-portion which seems to have been attacked in two places. Above is a slightly marked cicatrix, but below, the enlargement is without an opening of any kind; great disorganisation of the columnals has taken place.
 - . 4.—An almost bilaterally symmetrically enlarged portion, with several cicatrices, more or less closed.
 - . 5.—Barrel shaped stem-portion, with great columnal disorganisation. The cicatrix is covered by an encrusting Polyzoon.
 - . 6.—A somewhat barrel-shaped enlargement, with the faintest trace of a cicatrix.
 - . 7.—Section prepared for the microscope from the specimen illustrated in Fig. 6. Both the cavity and axial canal are infested by the Endophyte—x. 8.
 - . 8.—A similar section prepared from the subject of Fig. 4. The opening is shown at the right centre and an infection of nearly the whole of the interior of the stem-portion—x. 8.
 - . 9.—A third section prepared from the stem-portion represented in Fig. 1. The opening is seen on the right centre and along the sutures between the columnals, and in the axial canal are evidences of the Endophyte's work. This is also shown in certain parallel longitudinal lines passing through the cavity and the columnals—x. 3.



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PLATE V.

PALÆOPORONE ENDOPHYTICA, *Kth. fil.*

- Fig. 1.—Transverse section of a cavity (? enlarged autopore) in *Hexagonella dendroidea*, Hudleston, showing both full and empty parallel and sub-parallel tubes—x 60.
- „ 2.—A number of tubes forming portion of a more or less radiate mass from the transverse section of an autopore of *H. dendroidea*, with, at the upper ends of three of the tubes, protruding spores. The tubes are filled with the olive flocculent matter—x 60.
- „ 3.—Transverse section of a portion of an autopore of *H. dendroidea*, in which four large spores are visible, a pair, and two single ones. These are of a dense black colour, and protruding from the lower of the central pair is a short stolon—x 500.
- „ 4.—A slightly oblique section of autopores and mesopores of *H. dendroidea*, showing masses of pigment matter in two of the angles of an autopore, and nearly filling a mesopore; in both instances breaking up into spores—x 250 (about).
- „ 5.—A similar section from the same species, in which the disintegration of the pigment matter has gone a step further—x 250 (about).
- „ 6.—Pigment matter and spores from a transverse autopore section of *H. dendroidea*, arranged generally in linear series—x 250 (about).
- „ 7.—Another like section to that given in Fig. 6, but in which the linear arrangement is more marked—x 250 (about).
- „ 8.—An oval autopore in transverse section (*H. dendroidea*) in which the pigment matter has assumed a dendroid appearance, the branches being composed more or less of stolons and spores in linear series—x 250 (about).

All the figures in this plate, and Figs. 7-9 in Plate IV., are from carefully executed drawings by Mr. Edgar R. Waite.

1903.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 11.

NOTES ON THE COUNTRY

BETWEEN

KAJUDINA AND YUNDAMINDERA,

NORTH COOLGARDIE GOLDFIELD,

BY

A. GIBB MAITLAND,

GOVERNMENT GEOLOGIST.

WITH TWO MAPS.

*Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.*



PERTH:

BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.

1903.

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1. Progress Report for the Year 1897, containing—

Ferruginous Conglomerate at Coates' Siding; Geological Features and Mineral Resources of Northampton; Country between Northampton and Peak Hill; Geology of the Peak Hill Goldfield; Horseshoe Diggings; Artesian Water; Fumes from Fremantle Smelting Works; Native Tellurides of Gold; Mineralogical and Petrological Notes; So-called Deep Lead at Kanowna; The 25 Mile Cement Leases; Coolgardie Goldfield. (*Out of print.*)

1903.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 11.

NOTES ON THE COUNTRY

BETWEEN

EDJUDINA AND YUNDAMINDERA,

NORTH COOLGARDIE GOLDFIELD,

BY

A. GIBB MAITLAND,

GOVERNMENT GEOLOGIST.

WITH TWO MAPS.

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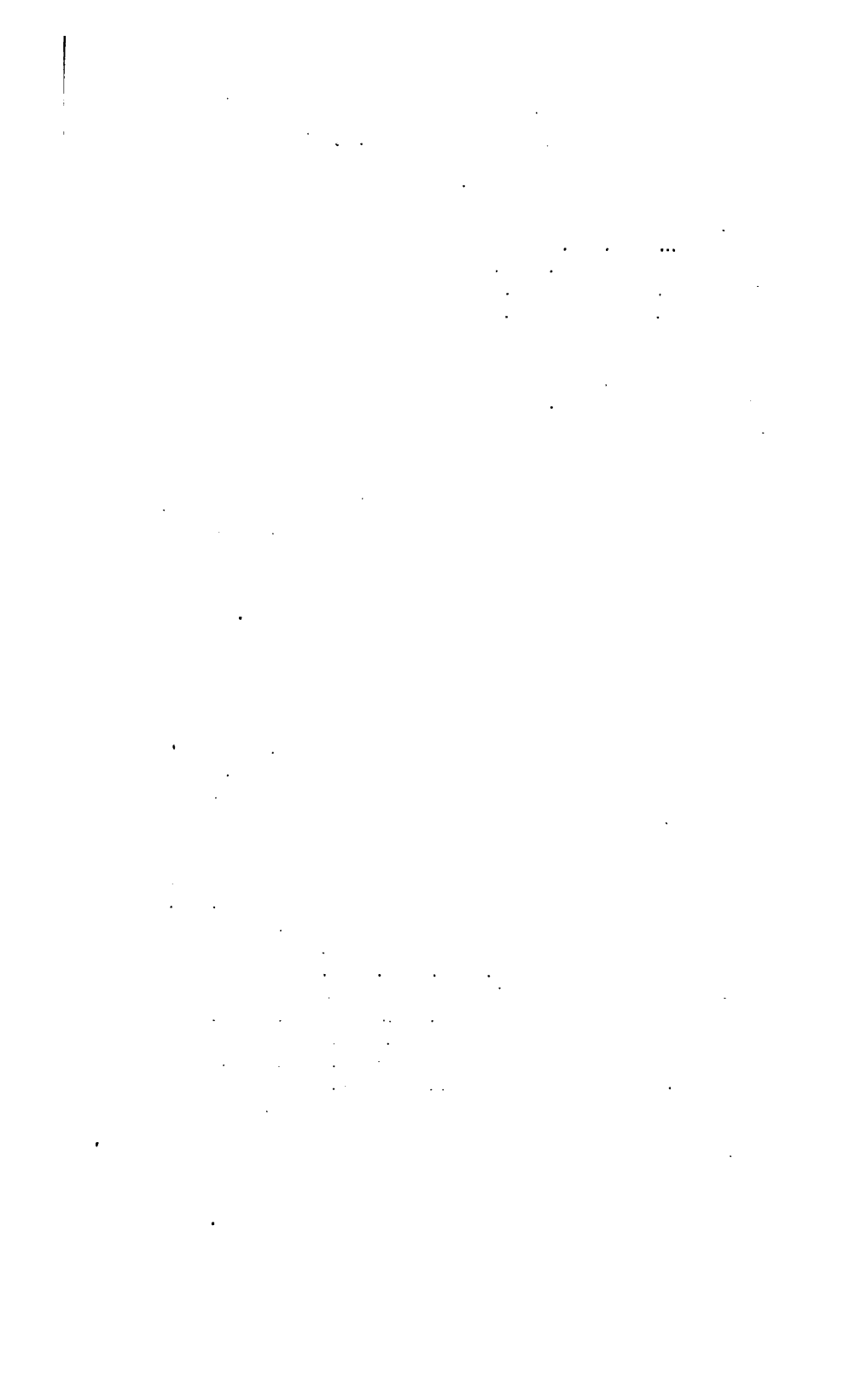
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- I.—Geological Sketch Map of Yarri and Edjudina.
- II.—Map of the Auriferous Quartz Reefs of Malcolm.



NOTES ON THE COUNTRY

BETWEEN

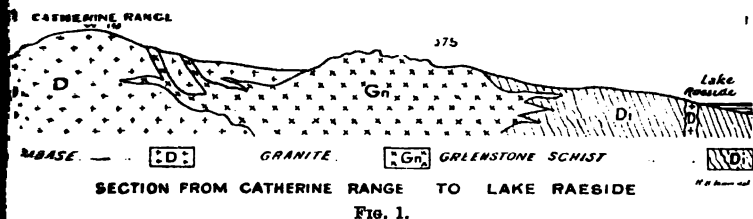
EDJUDINA AND YUNDAMINDERA.

GENERAL.

The country between Edjudina (Lat. $29^{\circ} 44' 40''$ S.) and Yundamindera (The Granites) was examined by myself in the early part of the year. Leaving Niagara, the route via Yerilla was followed. No mining was going on at Yerilla, hence very little was to be seen of the conditions of affairs prevailing underground.

Mount Cay (W 11), a low though conspicuous rise, situated some distance to the south-west of the Yerilla townsite, is formed of somewhat siliceous lateritic ironstone of the type prevailing in the district. No section was seen showing the rock upon which the bed rests.

To the south-eastward the Mount Catherine Range, upon the most conspicuous summit of which is situated Trig. Station W 19, consists of diabase. The diabase is intersected by dykes of granite as shown in a traverse from Catherine Range to Lake Raeside.



Some of these dykes pass gradually into coarse felspar porphyry (426, 4423). Further to the eastward the granite gives place to Grenstone schists, associated with which are bands of breccia (438), which may possibly be of volcanic origin.

These greenstone schists are traversed by diabase (?) dykes, a good section of one of these being exposed in the cliffs surrounding a small rocky island in the bed of Lake Baeside, bearing 211° from Mount Catherine. The dyke exposed on the eastern side of the island has a strike of 255° , is vertical, and about three feet in thickness. There are no sections visible which clearly prove the relation which the dyke rocks bear to the massive diabase of Mount Catherine, though the impression left on the mind is that they are part of the same igneous mass, and that the greenstone schists are much older.

Near the lake some low bluffs show a thin covering of laterite resting upon the weathered greenstone.

The Mount Catherine Reef, which was opened up in the early days, stands out boldly upon the surface, with an average strike of 188° degrees. The reef, a pure white quartz, is vertical, and, as measured in the crosscut which had been put in across the vein some distance below the surface, attains a thickness of about 12 feet. The reef has a considerable horizontal extent.

From Yerilla to Yilgangi the road wends generally south-east but few, if any, sections of the underlying rocks are exposed *en route*. Between Yilgangi and the well about three miles west from Yarri (New Edjudina), no sections of the underlying rocks were visible.

YARRI (NEW EDJUDINA).

The mining centre of Yarri (or New Edjudina) is situated about six miles west of Edjudina. The relative situations of these will be found by a reference to the geological map attached to this report, or the lithograph (L 50) issued by the Department of Mines.

The country rock consists of a massive greenstone (diabase), some portions being very coarse in texture (4417), penetrated by bosses of granite (4421), from which dykes of aplite (4420) emanate. The Government well has been sunk in granite. The quartz reefs traverse both the granite and the greenstone, as is well shown on the geological map. The reefs occurring in the granite, however, are, when viewed as a whole, approximately parallel to one another, and trend generally north-west. The reefs in the greenstone strike at varying angles, although when their position is laid down on a map a general east and west trend may be detected.

Whatever may be the date of the intrusion of the granite, it is quite clear that the formation of the auriferous quartz reefs took place much later.

The matrix of the reef in the Wallaby G.M.L. 581 is a transmuted granite, an analysis of which is shown in the Table I. herewith. A microscopic examination of this granite shows that the rock has undergone considerable dynamic alteration.

TABLE I.

Analyses of Rocks.

Geological Museum Number	4,426	4,419	4,417	4,425
Specific Gravity	2.64	2.67	3.04	3.04
Silica, SiO_2	70.82	71.55	46.55	48.06
Carbonic anhydride, CO_2 ...	.40	Nil	Trace	1.08
Phosphoric anhydride, P_2O_5	Trace	Trace	.06	Trace
Titanic oxide, TiO_2	.35	.74	1.12	.90
Combined Water, H_2O ...	.27	.55	1.31	.59
Soda, Na_2O	5.57	4.98	1.50	2.50
Potash, K_2O	1.94	1.56	.33	.27
Magnesia, MgO	.87	1.07	9.80	6.67
Lime, CaO	2.20	1.79	10.56	11.37
Manganese protoxide, MnO ...	.13	.89	.45	.59
Iron protoxide, FeO	1.73	1.58	8.79	10.37
Iron peroxide, Fe_2O_3 ...	.51	.77	3.19	.89
Alumina, Al_2O_3	15.56	14.82	15.36	16.21
Pyrites, FeS_2 : Iron, Fe ...	.09	.13	} Trace {	.16
Sulphur, S	.11	.15		.18
Hygroscopic Water, H_2O ...	.05	.21	.29	.10
	100.60	100.29	99.31	99.89
Analyst ... {	E. S. Simpson.	C. C. Williams.	E. S. Simpson.	E. S. Simpson.

4426.—Felspar porphyry. Mount Catherine Range, Trig. W 19, Yerilla, North Coolgardie Goldfield.

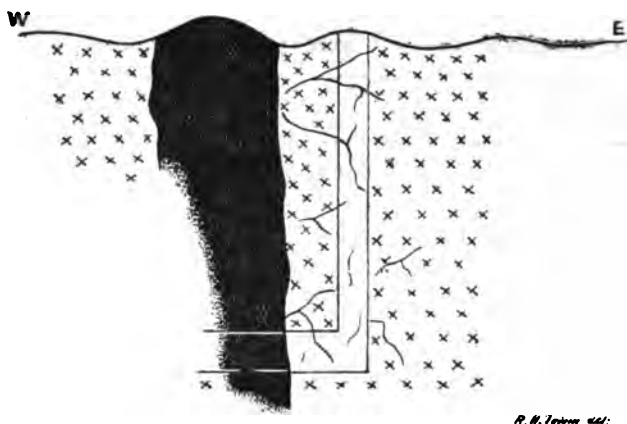
4419.—Transmuted granite. Wallaby G.M.L. 581R. Yarri, North Coolgardie Goldfield.

4417.—Coarse diorite. Yarri, North Coolgardie Goldfield.

4425.—Diabase. Mt. Malcolm, Mt. Margaret Goldfield.

WALLABY NORTH G.M.L. 579R.—Near the southern end of the lease a vertical shaft has been sunk through granite to a depth

of 60 feet, and from the bottom a drive has been put in for a distance of 10 feet, at which point the reef opened in the adjoining lease on the south was met with. The reef has been pierced for a distance of 14 feet, and at the date of my visit the whole thickness had not been ascertained. The reef had a slight underlie to the east.



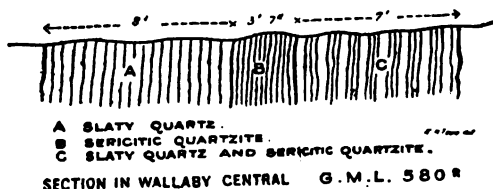
SECTION OF REEF IN THE WALLABY NORTH G.M.L. 579R

FIG. 2.

The country rock between the shaft and the reef is permeated with quartz leaders, which vary from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. in thickness; some of these are said to contain more or less gold. In the shaft are a few veins of quartz intersecting the granite.

In June, 1903, 21 tons of ore from this lease yielded 21·80ozs. of gold, being at the rate of 1·04ozs. per ton.

WALLABY CENTRAL G.M.L. 580R.—The reef worked in lease 579R enters the Wallaby Central, and traverses the whole length of the property. At 285 feet from the southern boundary of 580R, a trench has been put in across the reef, and exposes a width of 24 feet of quartz. One hundred feet from the trench is another 18 feet in width, showing the following section:—



SECTION IN WALLABY CENTRAL G.M.L. 580R

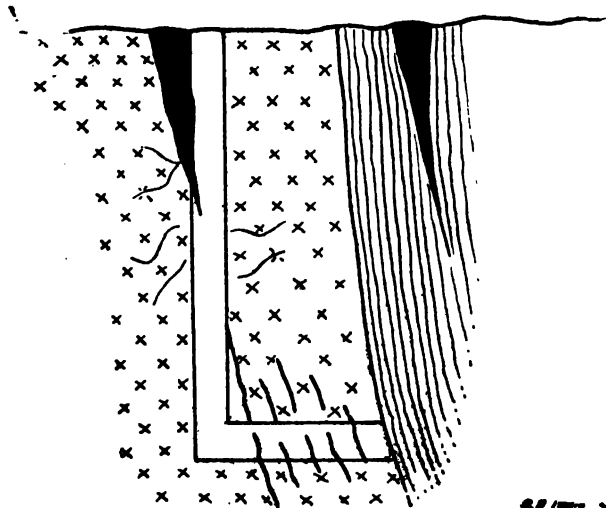
FIG. 3.

Distant 181 feet from the first-mentioned trench is a shaft 91 feet deep. The shaft, which has a slight underlie, has been put down on the foot-wall of the reef. Several leaders are passed through in the shaft. The owners of the property intend opening out on the reef when a depth of 100 feet has been attained.

Near the southern end of the lease a shaft has been put down to a depth of 35 feet, which, at the date of my visit, was inaccessible.

WALLABY G.M.L. 581r.—Upon this lease there are four distinct lines of reef outcropping, three of which traverse the whole length of the property from north to south. Operations at the date of my visit were confined to the easternmost reef, upon which three shafts had been sunk, known respectively as No. 1 shaft, Turner's, and No. 2 shaft.

The following section is exposed in No. 2 shaft, which is 418 feet from the north boundary of the lease:—

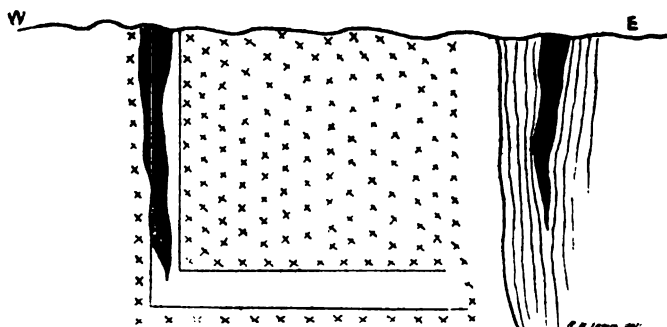


SECTION OF REEF IN N°2 SHAFT WALLABY G.M.L.581r

FIG. 4.

The shaft had been sunk to depth of 77 feet from the surface in granite. The bold reef peters out at a depth of 22 feet from the brace. From the foot of the shaft a crosscut has been carried 36 feet eastward, through a rudely foliated granite with quartz leaders along the planes of foliation; the crosscut has been carried along a joint for the whole distance.

What is known as Turner's shaft is situated 226 feet from No. 1 shaft. The shaft had been carried down to a vertical depth of 60 feet. The following section is exposed in the shaft:—



SECTION IN TURNER'S SHAFT WALLABY G.M.L. 581A

Fig. 5.

From the foot of the shaft a crosscut has been put for a distance of 65 feet, through nothing but transmuted granite, traversed by quartz leaders, running in all directions. The drive is said to be practically barren, assays yielding no gold. At the face of the crosscut the country rock is getting much harder, and carries a little pyrites. At the date of my visit the face of the crosscut was about 20 feet from the middle reef. Five feet north of Turner's shaft is what is known as No. 3 costeen, exposing 42 feet of quartz; 150 feet further south is No. 2 costeen, in which eight feet of quartz have been opened up; and 161 feet further is what is known as No. 1 shaft. This shaft has been sunk to a vertical depth of 55 feet; from the foot a crosscut goes to the east for a distance of 34 feet. The crosscut has been carried through transmuted granite, intersected by quartz veins ramifying in all directions; these, however, are said to carry no gold.

A costeen of 42 feet in length has been opened up 129 feet south of No. 2 shaft; it exposes 42 feet of quartz, which, however, only extends to a depth of three feet below ground. This crosscut is 325 feet from the southern boundary of the lease. The reef opened up extends along the surface for a distance of 900 feet within the boundary of the lease, and can be traced along the surface to the south through leases 582, 591, 587, and 585.

WILD DOG G.M.L. 582E.—Two shafts have been put down on the lease. The easternmost shaft has been put down on the underlie for a short distance, but very little stone is showing. The westernmost shaft is 25 feet in depth, and has been put down between two reefs, which are about 35 feet apart. From the foot of the shaft a crosscut has been put in to the west for a distance of 16 feet.

Just at the mouth of the crosscut a quartz reef of about one foot in thickness was encountered, whilst at the face a little quartz is showing; but, from what can be seen, it does not appear to be very thick. The stone is said to assay from 17 to 18dwts. of gold to the ton. The eastern crosscut has been continued for a distance of 19 feet through nothing but transmuted granite of the usual type.

RECORD G.M.L. 587E.—The boundary between the granite and the diabase runs through the centre of this lease. The ground has been exploited by means of a vertical shaft 37 feet 6 inches in depth, and situated near the south-eastern angle of the lease.

The shaft has been sunk in decomposed diabase, and from the foot a drive has been put in to the west for a distance of 14 feet through nothing but country rock. The western drive, eight feet in length, traverses similar country. From a point 45 feet distant from the shaft, a costeen 199 feet in length has been opened out to the west, with the object of exposing the country. The deepest part of the costeen is four feet. No reef was located in the trench.

A crushing of 16:50 tons of stone from this lease during June, 1903, yielded 33:31ozs. of gold, being at the rate of 2:02ozs. per ton.

QUEEN'S BIRTHDAY G.M.L. 585E.—A shaft has been sunk alongside the reef to a vertical depth of 50 feet. The reef, which is about 11 feet thick at the outcrop, trends practically north and south. The stone is a glassy quartz, of the nature which seems characteristic of the reefs in the diabase country of this district; the stone carries a little iron pyrites. It is intended to put in a crosscut at the foot of the shaft to intersect the reef at that depth.

A trial crushing of 10 tons from this reef during 1902 yielded gold at the rate of 23ozs. 18dwts. to the ton of quartz. The official records show that 33 tons were crushed during the early part of 1903 for 105:00ozs., being at the rate of 3:18ozs. per ton.

QUEEN'S BIRTHDAY SOUTH G.M.L. 614E.—Towards the northern end of the lease a shaft had been put down to a vertical depth of about 48 feet. At the foot of the shaft there is about one foot of quartz of the usual type showing. Near the southern boundary of the lease is a shallow prospecting shaft about 24 feet deep; but, beyond a few irregular quartz stringers, no reef appears to have been met with in sinking.

Sixty tons were crushed from this lease during April, 1903, for 39:87ozs. of gold, being at the rate of '66ozs. per ton.

NOVITIATE G.M.L. 630E.—A shaft has been sunk vertically through diabase country for a depth of 27 feet 6 inches. At 22 feet is a small quartz leader; from the foot of the shaft a drive goes east about 15 feet, and exposes a quartz vein of about six inches, dipping to the east at an angle of 45 degrees.

19·25ozs. of gold were obtained from specimens from this mine during 1902.

WISE STEP G.M.L. 641E.—A vertical shaft had been put down to a depth of 37 feet 6 inches through diabase country. The owners of the property contemplate continuing the shaft to a depth of 80 feet with the object of intersecting the reef, which outcrops at 44 feet from the shaft, by means of a western crosscut.

BEATRICE G.M.L. 632E (376E).—Upon this property there are five distinct quartz veins outcropping; several shafts have been sunk, and a fair amount of work carried out.

On what may be called the main reef two shafts have been sunk about 155 feet apart. The northernmost shaft, No. 1, has only attained a vertical depth of 23 feet. At the south end of the shaft there are about 6 to 18 inches of quartz showing. At about 10 feet from the surface a fair amount of work has been done, and a good deal of stone taken out. A drive has been put in about 15 feet to the south; just where the drive leaves the shaft about a foot of quartz is exposed, and at the face a like thickness of glassy quartz. From this shaft about 14 tons of quartz crushed about 18dwt. to the ton at the Neta battery at Edjudina. The south, or No. 2, shaft has a vertical depth of 37 feet. The reef exposed is vertical. From the outcrop, near the shaft, about 50 ounces of gold have been dollied by the previous holders of the ground some years ago. At the southern end of the shaft a drive has been put in for about 10 or 12 feet, and at the face about two feet of quartz is showing. Eighteen inches of quartz is showing at the north side of the shaft. About 50 feet north of the shaft the reef has been worked from the surface down to a depth of about 20 feet by the previous holders of the ground.

What is known as the western reef lies some distance from the one last described. Its position is fixed by the following bearings:—No. 1 shaft, 89° ; No. 2 shaft, 127° . This reef has been worked by the previous owners of the property. A shaft has been put down to a depth of about 34 feet, on a slight easterly underlie. From the foot of the shaft a drive 10 feet north shows:—

Diabase; quartz, three inches; formation, eight inches; quartz, nine to ten inches; diabase. At the south end of the shaft the following is exposed:—Diabase; quartz, six inches; formation, six inches; quartz, 14 inches; diabase.

About 80 feet to the west of this is another, which has just been opened on the surface; no work has been done upon it. Sixty feet east of the main reef is another parallel vein having a width of from 12 to 13 feet, as shown on the surface. Beyond laying bare the stone no further work has been done.

The following are the official returns from this lease:—

BEATRICE G.M.L. 622E.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	14'00	13'10	0'83
1903 to 30th June ...	24'00	21'31	0'89
Total	38'00	34'41	0'91

To the south of this lease is a claim (not shown on the map) held by Messrs. Byers and Co. An underlie shaft has been put down to the east, at an angle of about 45 degrees, for a distance of 15 feet. The shaft had been sunk upon a vein of about five inches in thickness, which, however, had petered out at the foot of the shaft. The country rock is diabase of the type prevailing in the district.

A traverse from Yarri to Mount Walbrook (W 9) showed the staple formation, after getting clear of the granite, to consist of greenstone schists, and the large quantity of quartz *débris* with which the surface was strewn in places seemed to indicate that there must be quartz veins associated with the schists.

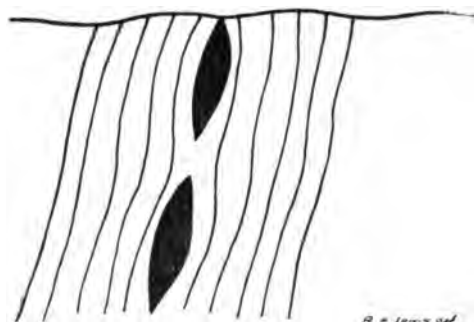
Mount Walbrook consists of a ridge of laminated quartzite, striking 338°. The quartzite is about 8 to 10 feet thick, and is vertical; it carries a little brown hematite of the usual type.

The granite of Yarri gives place to greenstone schist as the mining centre of Edjudina is approached.

EDJUDINA.

The mining centre of Edjudina is of interest in that a virtually continuous line of reefs has been proved to extend in a north-west and south-east direction for a distance of about 10 miles, and has been worked more or less along the whole line. The width of the belt embracing the auriferous quartz reefs nowhere exceeds 20 chains.

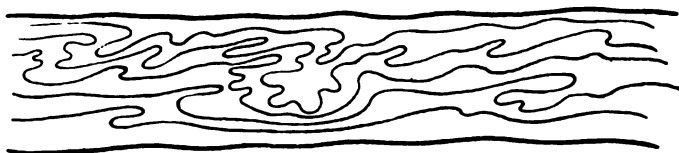
So far as may be seen the reefs consist of exceptionally lenticular veins of quartz occurring along the planes of foliation of the schist, thus :—



SECTION SHEWING THE MODE OF OCCURRENCE
OF THE EDJUDINA QUARTZ REEFS.

FIG. 6.

About two miles to the north-east, and parallel to the auriferous quartz reefs, is a long razor-backed ridge formed of the laminated hematite-bearing quartzites (cherts?) which can be followed for about 15 miles in the vicinity of Edjudina. The width of this belt of laminated quartzite is about 15 chains, and it is made up of a series of remarkably attenuated lenses, each of great horizontal extent. Several bands of quartzite occur within a few chains on either side of the auriferous quartz reefs, and can be followed with very little interruption along the known extent of the auriferous series. Wherever these quartzites can be seen in sections, they are either vertical or are inclined at high angles to the north-east, no lower dip than 68° having been observed. The ridge upon which Yabboo Hill (E 36) is situated extends for about five or six miles, and is made up of three bands of hematite quartzite. The band upon which the trig. station has been built is the most ferruginous. The central band is about 10 to 15 feet thick, and very much contorted thus :—



CONTORTED HEMATITE QUARTZITE.
YABBOO HILL

FIG. 7.

The quartzites are all enclosed in a slaty cleaved rock, of a nature which it is impossible to determine owing to the extensive

surface decomposition it has undergone. The rock, however, has the appearance of being a bleached greenstone schist. The southern end of the ridge disappears gradually into the low ground to the south. The summit of Yabboo Hill (E 36) is by aneroid 200 feet above the trig. station E 35 at Edjudina soaks.

The laminated quartzites range from an almost pure quartz, through varieties of beautifully banded jaspers, to what appears to the eye to be a practically pure hematite.

Table II. gives analyses of six typical varieties of the Edjudina iron ores.

TABLE II.

Analyses of Iron Ores from Edjudina (by E. S. Simpson).

Geological Museum Number.	4401.	4402.	4403.	4404.	4406.	4408.
Metallic Iron, Fe ...	37.38	25.86	26.69	33.45	38.33	22.85
Silica, SiO ₂ ...	45.05	60.82	59.55	51.76	43.10	61.19
Sulphuric anhydride, SO ₃	.08	.067	.096	.085	.062	.092
Phosphoric anhydride, P ₂ O ₅	.10	.138	.082	.100	.147	.198
Hygroscopic Water, H ₂ O	.17	.12	.05	.11	.12	.23
Combined Water, H ₂ O ...	.49	.87	.74	1.08	.93	4.24
Action on compass ..	None	None	Strong	None	None	None

4401—Banded hematite, E36, Yabboo Hills, Edjudina, N. Coolgardie G.F.

4402—Banded hematite quartzite, Yabboo Hills, Edjudina, N. Coolgardie G.F.

4403—Banded quartzite with hematite and magnetite, Cairn C., Yabboo Hills, Edjudina, N. Coolgardie G.F.

4404—Banded hematite, Cairn C., Yabboo Hills, Edjudina, N. Coolgardie G.F.

4406—Banded hematite, Hill B., Yabboo Hills, Edjudina, N. Coolgardie G.F.

4408—Ferruginous quartzite, Hill A., Edjudina, N. Coolgardie G.F.

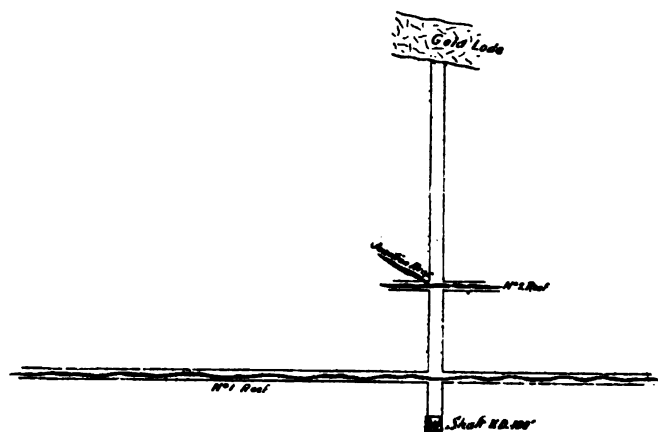
These analyses demonstrate that, contrary to the appearance of the ores themselves, they all contain a high percentage of silica and a relatively low percentage of iron. With the single exception of the last (4,408), they could be readily concentrated to high-grade ores. Although the percentage of sulphur is low, the phosphorus would seem to be too high for what is considered a requisite for the production of steel by the usual acid Bessemer process.

The following is a description of such of the mines along the Edjudina line as were open to inspection:—

NETA G.M.L. 401E (361E).—The Neta lease is being worked by a vertical shaft 100 feet deep, and two levels have been opened out. From the foot of the shaft a crosscut goes west for a distance

of 21 feet to what is known as No. 1 reef, upon which most of the work on the property has been concentrated.

The reef has been opened out to the southward for a distance of 200 feet at the 100 feet; the quartz is of the usual irregular type. Thirty-nine feet to the west of No. 1 reef is another known as No. 2, but at the date of my visit not much work had been done on it. One hundred and six feet further west is what is known as the "Gold lode," 20ft. 4in. in width. The "lode" is merely a band of decomposed country rock intersected by very thin veins of quartz and ironstone.



SKETCH PLAN OF THE NETA MINE O.M.L. 401^a

FIG. 8.

At the 50-feet level No. 1 reef is 22 feet from the shaft; 47 feet further west of it is No. 2 reef. In the crosscut, at 50 feet from the shaft, are two or three veins of quartz separated by narrow bands of a foliated sericitic rock.

The reef worked in this property can be followed northwards along the surface through leases 411 and 412.

The official records show that up to the close of 1902 3,202·5 tons of ore from this mine yielded 4,918·39ozs. of gold, as follow :—

NETA G.M.L. 401^R (361^E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	584·00	751·50	1·28
1899	1,165·50	1,549·49	1·32
1900	380·00	1,022·10	2·69
1901	145·00	818·20	2·19
1902	928·00	1,277·10	1·37
1903 to 30th June ...	811·00	1,004·80	1·23
Total	4,013·50	5,923·19	1·47

SENATE G.M.L. 539E.—The reef opened up in the Senate is in all probability the same as the Neta. The Senate reef has been worked by a vertical shaft 113 feet deep, situated close to the southern boundary of the lease.

At the foot of the shaft the reef has been opened up by a drive put in 120 feet to the north and 200 feet southwards. At the face of the northern drive about six to eight inches of quartz is exposed, but the average width is about 18 inches. To the face of the southern drive the reef is continuous, with some interruptions, but is very thin.

The official records show that 524·9ozs. of gold were obtained during 1902 by crushing 259 tons of ore, being at the rate of 2·02ozs. per ton.

GAWLER G.M.L. 497E (365E): The main shaft on this property is 100 feet deep. From the foot of the shaft a drive has been put in about 200 feet, which shows about one foot of quartz at the face. At about 170 feet from the shaft is a quartz lens of about three feet in thickness, but no great horizontal extent. The north drive has been carried about 200 feet, but at the date at which the mine was visited there was no stone showing in the face.

The official records show that up to the end of 1902 206 ounces of gold were obtained by crushing 130 tons of stone, as follow :—

GAWLER G.M.L. 497E (365E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	50·00	88·00	1·76
1902	80·00	118·00	1·47
Total	130·00	206·00	1·58

FINGALL G.M.L. 366.—The outcrop of two well-defined reefs traverse practically the whole length of the lease, but at the date of my visit work had evidently been abandoned for many years, and nothing could be seen. There are three shafts on the lease, and all the evidence seems to point to the fact that a good deal of work must have been done on the property.

WELSHMAN G.M.L. 368E (590E) (Louie Mary).—Upon this lease there is only one shaft in which work is going on. The shaft is 50 feet in depth, and operations were being carried out at 12 feet from the bottom. From the bottom of the shaft a crosscut of 120 feet in length, driven on a bearing of S. 50° W., connects with what was the old main shaft. Nothing, however, is showing in the crosscut. East from the shaft there is a small quartz reef exposed,

and at the face another of about 8 inches in thickness. The following are the official returns for this lease :—

LOUIE MARY G.M.L. 501E (368E.)

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	105'00	230'65	2'19
1901	25'00	30'00	1'20
Total	130'00	260'65	2'00

VULCAN G.M.L. 369E (667E).—No work was being carried out on the lease, and the shaft being inaccessible no description of the deposit can be given. From the material lying in the dump, it may be conjectured that the country rock encountered in sinking is greenstone schist of the usual type. A few yards west of the western boundary of the lease the surface is covered with fragments of hematite-quartzite of the type prevailing on the ridge to the west of the Neta battery. In all probability this band is the continuation of that which is virtually continuous as far as the Old Edjudina and Glengarry mines to the south.

The following returns have been recorded from this lease :—

VULCAN G.M.L. 667E (369E.)

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	90'00	58'06	'64
1901	160'00	126'30	'79
Total	250'00	184'35	'73

GOLDEN GIRL G.M.L. 370E (588E).—There is a line of shafts along the reef on the western boundary of the property, but these were inaccessible to me. The following are the official returns from this area :—

LOED NELSON G.M.L. 512E (370E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	50'00	62'50	1'25
1901	188'00	167'20	'89
Total	238'00	229'70	'96

GOLDEN GIRL G.M.L. 588R (370E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	21'00	21'70	1'08
1903 to 30th June ...	40'00	67'50	1'69
Total	61'00	89'20	1'46

ENTERPRISE G.M.L. 589R (371E, 604E).—Previously called BIG BEN (506R). Four quartz reefs of the prevailing type traverse the lease. A well-defined reef traverses the eastern boundary of the lease, which has been opened up in several places, and a good deal of stone raised from a depth of about 10 feet. In an open cut about five feet of quartz is exposed. The reef can be followed, with a few interruptions, to the southern boundary, where it enters the adjoining lease at 126 feet from the south-east angle of 371. An open cut about 60 feet in length exposes a good thickness of quartz of the prevailing type. At the boundary between G.M.L.'s. 371 and 372 the reef has pinched out to about two inches. A maximum thickness of about four feet of quartz is now visible in the open cut, which in its deepest part attains a depth of 13 feet.

A little distance to the west of the open cut a shaft about 20 feet in depth was, at the date of my visit, being sunk by the holders of the ground. The shaft was sunk in greenstone schist, with the object of following down a very small quartz leader.

The main shaft has been sunk to a vertical depth of 80 feet. From the foot of the shaft the reef has been driven on for a distance of 200 feet north, at which point it pinched out. A crosscut 24 feet in length connects with another shaft to the east. This shaft is 80 feet in depth, and has been carried down through greenstone schist of the prevailing type. The reef in the first-mentioned shaft has been driven on for a distance of about 100 feet in a southerly direction. At the face of the drive there are about 12 inches of quartz showing; it contains small quantities of carbonate of iron. The maximum width of quartz in the south drive is three feet six inches. The reef, however, is of lenticular habit, lens succeeding lens, being connected by threads of quartz.

Near the northern boundary of the lease a shaft has been put down to a depth of about 10 feet, with the object of prospecting two reefs about four feet six inches apart. The foot-wall reef is about from six to eight inches thick, and the hanging-wall vein three to four inches.

The following crushings have been recorded from this lease :—

BIG BEN G.M.L. 506R AND ENTERPRISE G.M.L. 589R.

Year.	Ore crushed.	Gold therefrom	Rate per ton.
	tons.	ozs.	ozs.
1900	30'00	9'00	30
1903 to 30th June ...	22'00	13'00	59
Total	52'00	22'00	42

HEATHCOTE G.M.L. 372.—No work was going on at the date of my visit, and the main shaft had been partly filled up. A good deal of quartz is lying round the mouth of the shaft. In 1900, 72 tons of stone were crushed for 38ozs. gold, being at the rate of 53oz. per ton.

M.A. 3 lies within what was originally known as G.M.L. 373. A deep shaft, at present inaccessible, occurs on this ground, but no particulars are obtainable in connection with it. There are also the remains of an old three-head battery, said to have been erected for crushing the dumps left by the previous holders of the ground.

ECLIPSE G.M.L. 373.—A vertical shaft is at present being sunk; and at the date of my visit had attained a depth of 30 feet. The shaft was put down with the object of intersecting a reef outcropping a little distance to the west.

PERSEVERANCE G.M.L. 374 (613R).—There are two shafts on the lease; the southernmost is inaccessible; the northern is 73 feet deep. The reef, which occurs along the foliation planes of greenstone schist, has a maximum thickness of three feet six inches. The reef has been opened up by drives 50 feet in length on the north, and a similar length to the south. The quartz is the usual bunchy lenticular type.

The official records show that during 1902 24 tons of stone were crushed for a yield of 40ozs. of gold from this lease, being at the rate of 1'66ozs. per ton.

THREE BROTHERS G.M.L. 383 (599R).—There are three reefs on this property. The most northerly shaft (1), sunk on the line of the largest reef, was inaccessible; hence no description of the workings can be given.

The western shaft (2), sunk on the middle reef, had been put down to a depth of 75 feet, and a drive 18 feet to the south had been opened out. There was only an inch or two of quartz, dipping at an angle of 68 degrees to the east. Shaft (3), situated in the south-east angle of the lease, was inaccessible.

The fourth shaft, situated about 80 feet south of No. 2, had been carried down to a depth of 75 feet vertically below the surface.

From the foot of the shaft drives had been put in north and south along the reef. The northern drive is about 30 feet in length, and shows 16 inches of quartz at the face.

SCOTCHMAN G.M.L. 384 (566R).—There are two lines of reef outcropping on this lease, and they are continuous throughout the whole length of the property, and extend as far to the southward as G.M.L. 274E.

The following are the official returns from this lease:—

SCOTCHMAN G.M.L. 566E (384E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	131'00	112'50	'86
1903 (to 30th June) ...	110'00	77'25	'70
Total	241'00	189'75	'79

G.M.L. 274E.—A good deal of work has been done on this lease, and a fair quantity of stone raised; but at the date of my visit the workings were inaccessible, hence little could be seen.

G.M.L. 273E.—A well-defined quartz reef outcrops along the western boundary of the lease. The reef, as exposed in a trench, is about 32 feet thick.

TRY IT G.M.L. 272E (665R).—What is probably the same reef as that outcropping in the adjoining lease on the north traverses this property, but very little work has been done upon it.

During the early part of 1903, 21 tons of ore from this lease yielded 9'08 ounces of gold, being at the rate of '43 ounces per ton.

G.M.L. 271E.—A quartz reef of about three feet in thickness makes a bold outcrop at a point about 55 feet from the north-west angle of the lease, and a shaft, now inaccessible, has been put down on it. At about 200 feet from the south-east angle there is an excavation about six feet in depth.

G.M.L. 270E.—There are three parallel reefs traversing this property. Near the south-west angle of the lease is a line of old and inaccessible shafts put down along the strike of the westernmost reef. Parallel to this, and close to the north-eastern boundary of the lease, is another equally persistent line of reef, which has been opened up by open cut along its strike. The stone is of the character prevailing in the district, and occurs in the form of lenses enclosed in a casing of sericite schist.

BELLA G.M.L. 275E (609R).—There are three distinct lines of reef traversing the lease, the eastern and western being those which extend from the adjoining ground in the north.

A vertical shaft 50 feet in depth was being sunk at the date of my visit. On the northern face of the shaft the quartz reef attained

a thickness of three feet. Gold was shewing freely in the stone lying at grass. A good deal of work had been done by the previous holders of the ground. The official statistics show the following crushings from this lease:—

BELLA G.M.L. 275E (609E).

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	64·00	105·70	1·65
1901	160·00	200·00	1·25
1903 (to June 30th)...	206·50	212·50	1·03
Total	430·50	518·20	1·20

Crow's NEST G.M.L. 277E (576E).—The reef worked on this property is the same as that opened out in the Bella, to the north. The present working shaft, near the northern boundary of the lease, is 30 feet deep, and shows 3ft. 6in. of quartz at the foot.

The adjoining shaft to the north, 80 feet distant on the same reef, has been put down to a depth of 50 feet; and the stone has been stoped out to the surface. The reef has been driven on for about 120 feet. There are about 160 tons of quartz lying at grass, some of which shows gold freely.

A good deal of work seems to have been carried out along the outcrop of a reef outcropping close to the south-western boundary. This reef extends into the adjoining lease to the south.

The following crushings are recorded from this lease:—

Crow's NEST G.M.L. 576E.

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	55·00	63·00	1·14
1903 (to 30th June)...	112·00	160·00	1·43
Total	167·00	223·00	1·33

G.M.L. 276.—The reef has been worked by means of a vertical shaft, which was inaccessible to me. Judging from the paddock of stone lying at grass, the reef must have been about 2ft. 6in. thick in places.

Parallel to this reef, and about 470 feet east, is another, which makes a characteristically bold outcrop on the surface. The width of the reef is about three feet six inches, but although it can be followed for a considerable distance along the outcrop, it does not appear to have been much worked.

G.M.L. 321.—A shaft has been sunk to a vertical depth of 25 feet, and a quartz reef of about two feet six inches in thickness exposed.

TRIUMPH G.M.L. 322E (605E).—The most southerly shaft on the lease was at work at the date of my visit. The reef opened up on the adjoining property on the north can be followed through the lease on a bearing of 147 degrees. Parallel to this reef is another to the east, upon which work was being carried on at the date of my visit. The vertical shaft had attained a depth of 35 feet. The reef is practically vertical, though with a perceptible underlie to the east. The reef is of the usual lenticular character. The easternmost shaft on the property had been carried down to a depth of 20 feet; the country rock has a slight dip to the east. On the foot wall of the reef is a very thin band of platy fissile quartzite. Adjoining this shaft on the north, and on the same line of reef, another shaft had been carried down to a depth of about 50 feet, and about 35 feet of stoping done on either side of the shaft. At the foot of the shaft the country rock underlies east at an angle of 65 degrees. About 50 tons of ore have been raised from this reef.

OLD EDJUDINA MINE G.M.L. 323E (623E).—A deep shaft, now inaccessible, apparently passed through little else than what appears to be a sericite schist. In the dump were several pieces of stone, showing irregular patches of quartz, encased between the laminae of the schist. The quartz contained a little iron pyrites and iron carbonate, and is evidently, as seems to be the case with most of the reefs, in the form of lenticles along the planes of schistosity. Judging by the size of the dump and the numerous small shafts, a good deal of work must have been done at one time or another.

GLENGARRY G.M.L. 493E (502E).—The main shaft on the lease had been carried down to a depth of about 150 feet. At 75 feet the reef had been opened up, and stoped out to the surface. Judging by the open cuts on the surface, a fair amount of work must have been carried out. The mine being practically under water, very little was to be seen of the nature and character of the reef. During 1901, 395ozs. of stone were crushed for 243·50ozs. of gold, being at the rate of 68ozs. per ton.

The Edjudina belt of hematite-bearing quartzites are continuous northwards across Lake Reside through Mounts Millicent W15, and Howe W14.

GOLD YIELD OF THE EDJUDINA DISTRICT.

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
AERIE G.M.L. 655E.			
1903 (to 30th June) ...	tons. 38'00	ozs. 55'00	ozs. 1'44

GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom	Rate per ton.
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ALPHA G.M.L. 681R.

1903 (to 30th June) ...	tons. 20'00	oss. 16'70	oss. '83
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ANGLO SAXON G.M.L. 204R.

Previous to 1898 ...	28'00	23'50	'84
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BEATRICE G.M.L. 622R.

1902	14'00	13'10	'93
1903 (to 30th June) ...	24'00	21'31	'88
Total	38'00	34'41	'90

BELLA G.M.L. 527R.

1900	64'00	105'70	1'65
1901	160'00	200'00	1'25
1903 (to 30th June) ...	206'50	212'50	1'03
Total	430'50	518'20	1'20

BIG BEN G.M.L. 506R.

1900	30'00	9'00	'30
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BRILLIANT G.M.L. 513R.

1901	30'00	57'55	1'92
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BROKEN HILL G.M.L. 610R.

1902	40'00	35'70	'89
1903 (to 30th June) ...	35'00	19'30	'55
Total	75'00	55'00	'73

BROKEN HILL NORTH G.M.L. 611R.

1903 (to 30th June) ...	17'00	4'86	'28
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CHEETABRA G.M.L. 676R.

1903 (to 30th June) ...	25'00	2'11	'08
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GOLD YIELD OF THE EDJUDINA DISTRICT—*continued*.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
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CONCORDIA G.M.L. 545R.

	tons.	ozs.	ozs.
1902	28'00	9'40	'33

CROW'S NEST G.M.L. 576R.

1902	55'00	63'00	1'14
1903 (to 30th June) ...	112'00	160'00	1'43
Total	167'00	223'00	1'33

ENTERPRISE G.M.L. 589R.

1903 (to 30th June) ...	22'00	13'00	'54
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EVA G.M.L. 522R.

1902	29'00	57'00	1'96
1903 (to 30th June) ...	29'00	57'00	1'96
Total	58'00	114'00	1'96

GAWLER G.M.L. 497R.

1901	50'00	88'00	1'76
1902	80'00	118'00	1'47
Total	130'00	206'00	1'56

GLENGARRY G.M.L. 502R.

1901	359'00	243'50	'68
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GOLDEN GIRL G.M.L. 588R (late LORD NELSON
G.M.L. 512R.)

1900	50'00	62'50	1'25
1901	188'00	167'30	'89
1902	21'00	21'70	1'08
1903 (to 30th June) ...	40'00	67'50	1'69
Total	299'00	318'90	1'06

HEATHCOTE G.M.L. 503R.

1900	72'00	38'00	'53
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GOLD YIELD OF THE EDJUDINA DISTRICT—continued.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
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HIGHLAND MARY G.M.L. 578R.

1902	...	...	...	tons. 46'00	ozs. 52.50	ozs. 1'14
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LOUIE MARY G.M.L. 501R.

1900	...	...	...	105'00	230'65	2'20
1901	...	...	...	25'00	30'00	1'20
Total	...	...	...	130'00	260'65	2'00

LYON GLEN G.M.L. 677R.

1903 (to 30th June)	...	...	...	84'00	108'70	1'29
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MAID MARION G.M.L. 653R.

1902	...	...	...	17'00	13'00	76
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MT. EIVERSLEY G.M.L. 460R.

1899	...	...	...	55'00	61'00	1'11
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NETA G.M.L. 401R.

1898	...	...	...	584'00	751'50	1'28
1899	...	...	...	1,165'50	1,549'49	1'33
1900	...	...	...	380'00	1,022'10	2'69
1901	...	...	...	145'00	318'20	2'19
1902	...	...	...	928'00	1,277'10	1'37
1903 (to 30th June)	...	...	...	811'00	1,004'80	1'24
Total	...	...	...	4,013'50	5,923'19	1'47

NETA EXTENDED G.M.L. 418R.

1899	...	...	...	104'00	118'18	1'13
1900	...	...	...	622'50	681'90	1'09
1901	...	...	...	456'00	863'70	1'89
Total	...	...	...	1,182'50	1,663'78	1'40

NINETY-NINE G.M.L. 459R.

1899	...	...	...	30'00	10'45	35
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GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
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OUTCAST G.M.L. 523R.

	tons.	ozs.	ozs.
1900	30'00	41'60	1'38
1901	30'00	29'00	'97
Total	60'00	70'60	1'17

PERSEVERANCE G.M.L. 613R.

1902	24'00	40'00	1'66
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QUEEN'S BIRTHDAY G.M.L. 585R.

1903 to 30th June ...	33'00	105'00	3'18
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QUEEN'S BIRTHDAY SOUTH G.M.L. 614R.

1903 to 30th June ...	60'00	39'87	'66
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RECORD G.M.L. 587R.

1903 to 30th June ...	16'50	33'31	2'02
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RETURN G.M.L. 680R.

1903 to 30th June ...	25'00	16'50	'66
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ROCKY RIDGE G.M.L. 679R.

1902	8'00	10'30	1'29
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SCOTCHMAN G.M.L. 566R.

1902	131'00	112'50	'86
1903 to 30th June ...	110'00	77'25	'70
Total	241'00	189'75	'79

SENATE G.M.L. 539R.

1902	259'00	524'90	2'02
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TRIUMPH LEASES, LTD., G.M.L.s 13/8R, 244/5R, 308R.

Previous to 1898 ...	1,747'00	1,648'00	'94
1898	515'00	565'30	1'09
Total	2,262'00	2,213'30	'97

GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
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TRY-IT G.M.L. 665R.

1908 to 30th June ...	tons. 21'00	ozs. 9'08	ozs. '43
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UNDAUNTED G.M.L. 510R.

1901	65'00	64'35	'99
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VULCAN G.M.L. 498R.

1900	90'00	58'05	'64
1901	160'00	126'30	'79
Total	250'00	184'35	'73

WALLABY NORTH G.M.L. 579R.

1903 to 30th June ...	21'00	21'30	1'04
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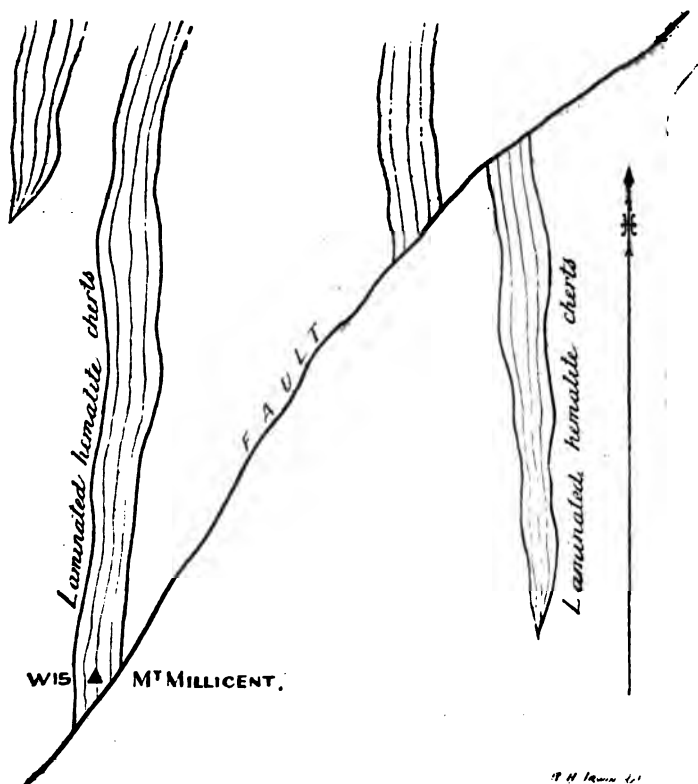
SUNDEY CLAIMS AT EDJUDINA.

1899	75'00	72'30	'96
1900	57'00	54'52	'95
1901	381'00	352'14	'92
1902	283'00	338'30	1'19
1903 to 30th June ...	32'00	105'00	3'28
Total	828'00	923'26	1'11

Mount Millicent (Reedy's Bluff) rises to a height of about 450 feet above the level of the surrounding country. The quartzites (4633, 4634) of the summit present all the usual gradations between a practically pure quartz rock, through beautifully ribboned jaspers to a laminated hematite quartzite. As is the case at Edjudina, the belt is formed of two or three bands of quartzite, at varying distances apart, one band lying about two miles to the east of the main belt. The highest ridge of the Mount Millicent group is formed of a brecciated form of the hematite quartzite; the breccia (fault rock) being formed of angular fragments of quartzite, jasper, and hematite, cemented together by secondary silica. Many of the bands are minutely puckered and contorted between their walls, though it is only occasionally that their place is taken by breccias. All the available evidence seems to indicate that these lines or bands of quartzite have been formed along sheer planes, and that faulting took place subsequently to the deposition of the iron ores themselves.

At the summit of Mount Millicent the hematite quartzites are very highly contorted and puckered, and have a dip of, in one place, 65 degrees to the north-east.

In addition to movement along the line of the quartzites, a section in the vicinity of Mount Millicent shows an excellent example of the sudden truncation of a quartzite band, by a vertical fault bearing 124 degrees. The contorted quartzite ends abruptly in a perfectly smooth wall, about 10 or 20 feet in height, and is shifted to the west for several feet. This fault, which is shown in the accompanying section, is probably responsible for the truncation of the band which forms Mount Millicent.



PLAN OF NEIGHBOURHOOD OF MT MILLICENT

NOT TO SCALE

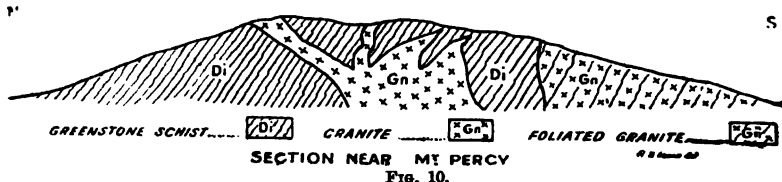
FIG. 9.

Somewhat similar brecciated and contorted hematite quartzites are continuous to Mount Howe, W14, which rises, according to aneroid measurements, to an altitude of about 500 feet above the surrounding country. The belt has a general strike of 168 degrees,

and is continuous for about 10 miles to the north, where it is crossed by the main road from the Quartz Blow Soaks to Linden. Here the quartzites are encased in a decomposed slaty rock, which there are good grounds for believing to be merely bleached forms of the greenstone schists which make up the country on either flank of the ridge.

West of Mount Howe (W14) is Mount Percy (E67), which rises to a height of 580 feet above the level of the plains.

A low though conspicuous rise about five miles east of Mount Percy, and bearing 308 degrees therefrom, shows a section which seems to demonstrate the relation which the granite rock bears to the greenstone and allied basic rocks.



This low rise is made up of greenstone, which has been rudely foliated or cleaved, along a bearing of 119 degrees. This has been invaded by dykes of a fine-grained granite rock (4636). Near the northern end of the rise the surface is occupied by a foliated granite, the strike of the foliation planes being parallel with those of the neighbouring greenstone. This section is of importance in that it seems to indicate that there are granites of two totally distinct geological ages in the district.

Mount Percy (E67) forms one of the highest summits of a fairly extensive series of hills, drained by numerous gullies, which all discharge their waters into Lake Raeside. The mount, as well as the whole of the hills, is formed of diabase (4637), intersected by dykes of granite of the usual type. These dykes, doubtless, emanate from that extensive mass of granite which extends from Yundamindera to Quartz Blow Soaks, and Mount Catherine.

LINDEN.

The mining centre of Linden, at present practically at a standstill, lies about eight or nine miles to the east of the Edjulina and Camel Back Soak belt of iron-bearing quartzites. The productive centre lies just along the junction of the greenstones and allied rocks with the granite, which may form part of the Quartz Blow Soak mass.

Mount Linden (W8), which rises to 140 feet above the plains, is formed of bands of ferruginous quartzite (4626), striking 320 degrees and dipping north at an angle of about 50 degrees. The quartzite (chert?) is seamed with veins of secondary silica.

The following are the particulars of such of the properties as were open to inspection at the date of my visit:—

GREAT CARBINE G.M.L. 406R.—This property is situated some distance to the south of Mount Linden and beyond the limits of the Mines Department lithograph L28.

The reef, which has been worked, has a strike of 267 degrees and underlies to the north at a high angle. A vertical shaft has been sunk to a depth of 50 feet; on the eastern face of the shaft, and at the foot, there is a quartz reef about two feet in thickness exposed. This reef has been worked for about 50 feet along the strike; at the western face of the drive there is about 18 inches of quartz. The reef has been practically all stoped out to the surface from the 50 feet level.

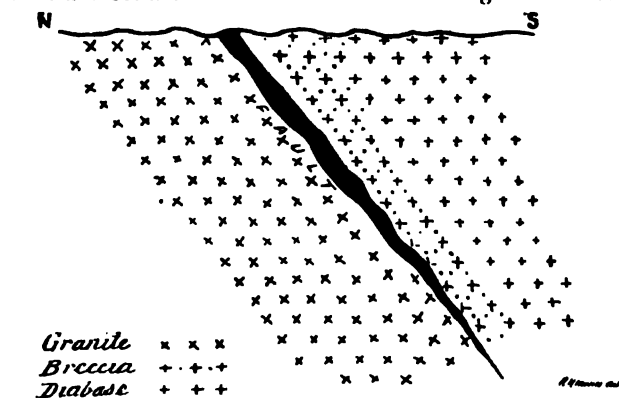
Free gold can be seen in some of the quartz, in addition to a little pyrites. From this reef 294 tons of quartz crushed have been officially reported as yielding 178·2 ounces of gold, as follows:—

GREAT CARBINE G.M.L. 406R.

Year.	Ore treated.	Gold therefrom.	Rate per ton.
	TONS.	OSZ.	OSZ.
1898	36·00	42·70	1·18
1899	5·00	7·25	1·45
1900	253·00	128·25	·50
Total	294·00	178·20	·60

GOLDEN RIDGE (FEDERAL) G.M.L. 3314.—This property was not at work at the date of my visit, and had evidently been abandoned for some considerable time.

As seen on the surface, the strike of the reef is north 60° east. The reef occurs along a faulted junction of granite and diabase, which underlies to the south at 51 degrees. The reef, which is not very thick, has been worked for some distance on the underlie. The granite foot wall shows well-marked slicken-sided faces trending in the direction of the underlie of the reef. The hanging wall of the reef is a brecciated diabase. Gold is showing in the stone.



SECTION OF THE GOLDEN RIDGE REEF G.M.L.3314.

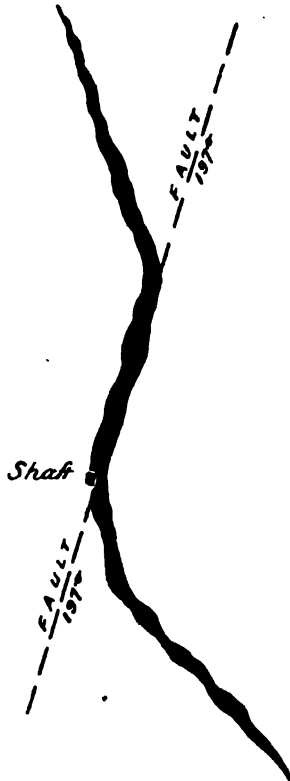
The following are the official returns from this lease :—

Year.				Ore crushed.	Gold therefrom.	Rate per ton.
				tons.	ozs.	ozs.
1898	...	...	...	10'00	6'95	6'89
1899	...	...	...	26'25	†166'23	6'33
1900	...	...	...	52'75	*69'15	1'31
1901	...	...	...	18'60	40'30	2'16
Total				107'60	282'63	2'62

† Includes 18'98ozs. dollied and specimens. * Includes 2'25ozs. dollied and specimens.

G.M.L. 4240.—No work was going on at the date of my visit to the property. A quartz reef enters the lease on its southern boundary at a point about 160 feet from the south-east angle of the property, on a bearing of 327 degrees. The reef has been opened up by a shaft of unknown depth. A good deal of stone has been raised, and is now lying at grass, but so far as a casual inspection went no gold could be seen in any of it.

The following is a plan of the reef :—



PLAN OF REEF IN G M L 4240

Further to the north, along the line of reef is an east and west cove in which two reefs have been exposed. The reefs, which underlie to the westward, are about 20 feet apart, and lie parallel to the one opened up in the southern shaft.

The northernmost shaft is also inaccessible. A quartz reef, bearing 127 degrees, passes through it. This reef has an underlie of 48° to south 60° west.

G.M.L. 4241.—The greater portion of this lease lies in Lake Carey, which extends much further to the south than is shown on the existing litho. L28. Although this lease lies within the boundary of the lake it is not covered with any material thickness of alluvium, for the underlying greenstone schists crop out in the floor of the lake.

Near the north-west angle of the lease is a quartz reef bearing 265° which has been opened up by former holders of the ground. The reef, which underlies to the north, has a thickness of about two feet.

G.M.L. 4237.—Near the north-east angle of the property, which is situated on the western shores of the southern end of Lake Carey, is a quartz reef of 18 inches in thickness, with a strike of 42° , and underlying at a high angle to the north.

At a point bearing 42° from the north-east angle of the lease, and about 250 feet therefrom, the small 18-inch reef is joined by a larger one of six feet six inches, having a strike of 333° . This reef has a considerable horizontal extent, and disappears in the adjoining lake to the north. It gradually peters out northward, but its place is taken by another parallel reef, the outcrop of which lies a few feet to the east, and the strike of which is 335° . The figures below show the relation of these reefs to one another:—

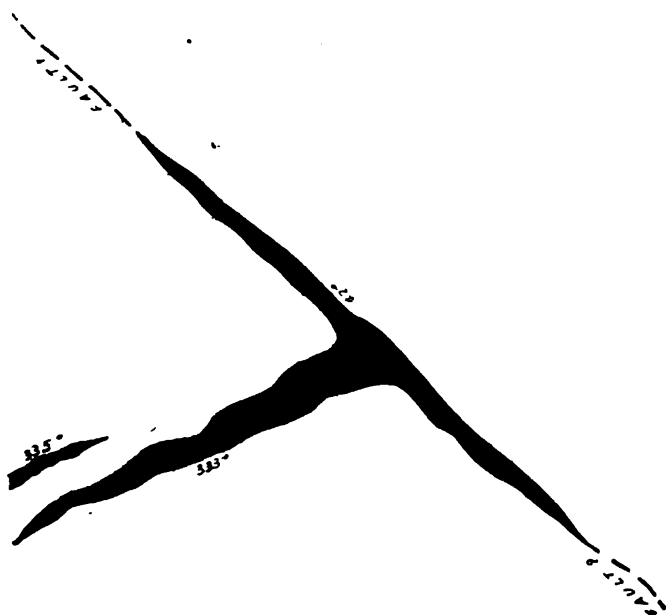


FIG. 13.—Plan of Reefs in G.M.L. 4237.

G.M.L. 4236.—The easternmost reef mentioned above as occurring in the adjoining property on the north passes through this lease and disappears beneath the surface of the lake not far from the southern boundary of G.M.L. 4235.

No work of any consequence appears to have been done on this reef.

MT. WILGESS G.M.L. 357R.—This lease forms the centre of a group of five, trending northwards from the north-eastern corner of the proclaimed boundary of the Linden townsite.

A main shaft has been put down on the northern brow of a relatively low ridge, which trends north-west and south-east, but owing to the abandonment of the property, access to the workings is not possible.

A few feet west of the shaft a bluish white quartz reef, underlying to the east, outcrops, and a fairly large reef outcrops a few feet to the east. The western reef has an average strike of $131^{\circ} 30'$, and the eastern 148 degrees.

From the cubical cellular spaces in the western reef, it is evident that the quartz contains a reasonable proportion of pyrites at a depth; this reef, as measured on the surface, is about three feet in thickness and underlies eastward at 61° .

Returns show that in 1897 nine tons of stone from this lease were crushed for 7.50 ounces of gold, equal to .83 ounces per ton.

G.M.L. 286.—A reef bearing $153\frac{1}{2}$ degrees outcrops at some distance to the east of that last mentioned. This reef has been opened up for about a chain along its outcrop to a depth of about 20 feet. So far as could be judged from the surface, the reef has a thickness of about two feet.

GOLD YIELD OF THE LINDEN DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
BLAIR ATHOL G.M.Ls. 188R, 196R.			
	tons.	ozs.	ozs.
1899	104'00	278'80	2'68
1900	9'00	117'00	13'00
1901	..	*11'17	...
Total	113'00	406'97	3'60

* Plates and extras.

BURGESS LUCK G.M.L. 399R.

1898	27'00	*520'00	19'25
1899	...	†7'83	...
Total	27'00	527'83	19'55

* Includes 460ozs. dollied and specimens.

† Dollied.

GOLD YIELD OF THE LINDEN DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
CALEDONIAN G.M.L. 413R.			
1898	tons. 25'00	oss. 27'75	oss. 1'11
1899	48'00	23'78	'49
Total	73'00	51'48	'70

CRUSHED TRAGEDIAN AND TRUE BLUE G.M.Ls. 286R,
285R.

1897	19'00	*41'35	2'17
1898	19'00	28'10	1'47
Total	38'00	69'45	1'83

* 18ozs. dollied.

FEDERAL G.M.L. 464 (LATE GOLDEN RIDGE
G.M.L. 123R).

1898	10'00	6'95	'69
1899	26'25	*166'23	6'33
1900	52'75	†69'15	1'31
1901	18'60	40'30	2'16
Total	107'60	282'63	2'62

* Includes 12'98ozs. dollied and specimens.
dollied and specimens.

† Includes 2'25ozs.

GREAT CARBINE G.M.L. 406R.

1898	36'00	42'70	1'18
1899	5'00	7'25	1'45
1900	258'00	128'25	'50
Total	299'00	178'20	'60

GREENHILLS G.M. Co., G.M.L. 408R.

1898	40'00	185'50	4'64
1899	1,314'00	2,689'90	2'04
1900	1,676'00	2,566'95	1'53
1901	168'00	811'75	4'83
1902	...	181'40*	...
Total	3,198'00	6,435'50	2'01

* From tailings by cyaniding.

GOLD YIELD OF THE LINDEN DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
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KANGAROO G.M.L. 414R.

1898	...	...	...	tons. 18'05	ozs. 9'25	ozs. '51
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LADY EDITH G.M.L. 484R.

1898	...	...	...	69'00	243'60	3'53
1899	...	...	...	105'50	451'00	4'27
Total	...	...	...	174'50	694'60	3'98

LADY ETHEL G.M.L. 387R.

1898	...	...	...	252'00	293'55	1'16
1899	...	...	...	295'25	524'95	1'77
1900	...	...	...	239'00	384'40	1'60
1901	...	...	...	30'00	20'05	'66
Total	...	...	...	816'25	1,222'95	1'49

LAKE VIEW AND BOULDER EAST G.M. Co., G.M.

LEASES 188R, 196R, 384R, 123R, 320R.

1897	...	...	...	522'00	810'75	1'55
1898	...	...	...	61'00	34'20	'56
Total	...	...	...	583'00	844'95	1'44

MOUNTAIN MAID G.M.L. 430R.

1898	...	...	...	3'50	4'10	1'17
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MT. WILGRESS G.M.L. 357R.

1897	...	...	...	9'00	7'50	'83
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NEW YEAR'S GIFT G.M. Co., G.M.L. 407R.

1899	...	...	...	164'00	112'00	'68
1900	...	...	...	12'00	11'00	'91
Total	...	...	...	176'00	123'00	'69

RECOVERY G.M.L. 468R.

1899	...	...	...	8'00	51'85	6'48
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GOLD YIELD OF THE LINDEN DISTRICT—*continued.*

Yield.	Ore treated.	Gold therefrom.	Rate per ton.
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TRAVELLERS JOY G.M.L. 420R.

	tons.	ozs.	ozs.
1898	37'00	46'55	1'25
1899	18'00	24'50	1'36
1900	16'00	36'00	2'25
Total	71'00	107'05	1'50

TRUE BLUE JACKET G.M.L. 295R.

1897	12'00	18'60	1'55
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WIMMERA G.M.L. 358R.

1897	22'00	56'60	2'57
1898	85'00	136'18	1'61
1899	145'50	185'30	1'27
1900	120'00	* 179'27	1'49
1901	44'00	52'60	1'19
Total	416'50	609'93	1'46

* Includes 4'20ozs. doliied and specimens.

PORTSEA G.M.L. 188R.

1898	76'00	51'52	'67
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SUNDEY CLAIMS AT LINDEN.

1899	68'75	96'80	1'40
1900	112'75	149'40	1'32
1901	46'00	40'50	'88
1902	11'00	11'50	1'04
Total	238'50	298'20	1'25

The country in the vicinity of Linde Mia (Pindinnie Soak) Reserve 5214, is all granite, of the usual type. This granite is intersected with several large quartz reefs which stand out in bold relief, and make prominent marks in the landscape, the most pronounced of these being that at the Quartz Blow Soaks Reserve 5580, about eight miles south-east of Linde Mia. This reef has a general strike of 115 degrees. To the west of Linde Mia, and about three miles distant, is another similar reef, which rises to an altitude of about 50 feet above the surrounding country, out-cropping for a distance of about a quarter of a mile, on a bearing

of 79 degrees. The quartz is pure white and destitute of mineral of any kind. Below Linde Mia and the almost deserted mining centre of Eucalyptus, granite occupies the country as far as Old Joe's Soak, Reserve 6561. A short distance to the east of the soak, and on the south side of the road, is a small hill which exposes an interesting section, shown below :

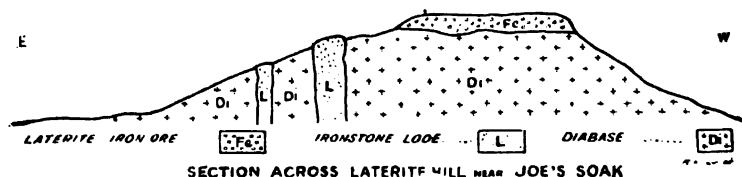


FIG. 14.

The summit of the hill is formed of a thin capping of pisolitic iron ore (4639), which may possibly conceal an ironstone lode. Lower down the eastern slope of the hill are two vertical ironstone lodes (4640), about two feet in thickness in diabase. These have their outcrops partially decomposed into pisolitic iron ore, similar in character to that capping the summit of the hill. On the face of the ridge is a scree or talus of weathered iron ore, which bids fair to become in time a pisolitic iron ore also.

A little further to the east, the Eucalyptus road surmounts a low tableland of laterite, which occupies the country within a short distance of the diggings.

YUNDAMINDERA (THE GRANITES).

The auriferous reefs of Yundamindera occur along the eastern boundary of the belt of granite (4643) which extends from Lake Raeside northwards. Some portions of the granite have a rude foliation, and contain lenticular patches of what may be correctly described as micaceous schist (4644). Some of the quartz reefs, from their laminated nature, have evidently undergone a certain amount of crushing since their formation.

Very little in the way of mining was going on at the date of my visit, but the following is a brief description of such of the properties as were open to inspection:—

LANDED AT LAST G.M.L. 443R (POTOSI Co.).—The outcrop of what may be called the main reef strikes north-west and south-east, and underlies to the N. 35° E. at 32 degrees. The reef has been opened up by an underlie shaft from 130 feet to 150 feet in length, from which two levels have been driven. In No. 1 level the quartz is of a characteristic laminated type. No. 2 level, which has been driven 120 feet to the north, shows an irregular body of laminated quartz, encased in a coarse, micaceous granite of the type prevailing in the district; to the southward the level has been driven for a distance of 35 feet. At the foot of the underlie the width of the reef between the walls is five feet.

Parallel to this reef on the east, and distant about 51 feet, is another one of a similar character, which underlies at the same angle and in the same direction, but very little work appears to have been done upon it.

The official returns from this mine show that, during the years 1899 and 1900, 60 tons of quartz yielded 82·05 ounces of gold, as follows :—

LANDED AT LAST G.M.L. 443R.

Year.				Ore crushed.	Gold therefrom.	Rate per ton.
				tons.	ozs.	ozs.
1899	...	...	...	37·00	44·05	1·19
1900	...	...	...	23·00	38·00	1·65
Total	...	...	...	60·00	82·05	1·36

GREAT BONAPARTE G.M.L. 480R (POTOSI Co.).—An east and west reef underlying to the north at an angle of 50° has been opened out at 80 and 90 feet, but no work was going on at the date of my visit. The reef is an irregular rock-bound quartz vein, enclosed in granite of the usual type. The manager of the property, Mr. Kidd, informs me that on careful sampling the stone yielded no values.

MAORI QUEEN G.M.L. 541R.—The reef on this property is one which extends to the south-east, and traverses the two adjoining leases. The reef can be followed along the surface for over half a mile. There are three shafts on the lease. The northernmost shaft has been sunk for a distance on the underlie of a reef which is of the usual type, enclosed in granite. At the foot of the shaft drives have been put in north and south, and expose a variable thickness of quartz of the usual type. The country on both the hanging and the foot wall side of the reef has been explored by crosscuts, but nothing but granite laid bare.

The central shaft has been carried down to a vertical depth of 150 feet, but owing to the water the mine was inaccessible below the 100 feet level.

At 75 feet a level has been driven to the south-east for a distance of 100 feet, but at the face no quartz is showing. A crosscut of 10 feet in length has been put in to the north-east, and a drill-hole eight feet further in from its face, which exposed nothing but granite of the usual type. The section in this drive shows that the reef occurs along a fault fissure. Northwards from the shaft a drive has been put in for a distance of 40 feet, and a crosscut 16 feet to the south-west has intersected a quartz reef of about two feet six inches in thickness.

At 100 feet from the surface a drive has been put in 90 feet northwards, but at the date of my visit this was inaccessible, but is

said to have exposed three or four inches of quartz of the usual type. To the south the level has been driven 75 feet. A crosscut 20 feet in length has been put in in an east-north-east direction, and intersected a thin quartz reef, and another a few feet further in.

This mine makes water at the rate of 3,000 gallons per diem.

The southern shaft had at the date of my visit attained a depth of 15 feet; it was contemplated continuing it until the reef met within the adjoining shaft to the north had been intersected.

The following are the yields from this lease :—

MAORI QUEEN G.M.L. 541r.

Year.	Ore crushed. Gold therefrom.		Rate per ton.
	tons.	oss.	oss.
1901	70'00	125'00	1'78
1902	290 00	582'50	2'01
Total	360'00	707'50	1'96

TREASURE EAST G.M.L. 493r.—The reef opened out in the Maori Queen extends throughout the whole length of the property, and a good deal of work has evidently been carried out. At the date of my visit to the mine water was standing up to No. 2 level. The mine is capable of yielding water at the rate of 150,000 gallons per diem. Along No. 2 level there is about an average of two feet of quartz exposed. Some crushings have been taken out of this mine, but owing to the fact that they are included with those from the other leases (443, 457, and 463) held by the London and Hamburg Gold Recovery Company, the exact yield of the stone from this lease cannot be given.

PRETORIA G.M.L. 511r.—There are three shafts on this property, all of them put down upon the reef opened out in the two adjoining properties on the north. There is not very much to be seen at the present time in the workings.

The most noteworthy shaft has been sunk 10 feet vertically to the reef, thence down the underlie 140 feet to the north-east, the reef showing all the way down the shaft. At the 90 feet level a drive has been put in 50 feet northerly and thence 70 feet southerly.

The central shaft on the same reef had been carried down 50 feet, through granite of the usual type. From the foot of the shaft a crosscut has been put in to the west, which, at a point 15 feet from the mouth, passed through four inches of quartz dipping to the north-east. A western crosscut exposes at 23 feet from the shaft a quartz reef of two feet in thickness, underlying to the north-east.

The most southerly shaft is inaccessible.

From the official records it appears that during the years 1901 and 1902 55 tons of quartz yielded 56·05ozs. of gold, as follows:—

PRETORIA G.M.L. 511R.

Year.				Ore crushed.	Gold therefrom.	Rate per ton.
				tons.	ozs.	ozs.
1901	...	...	...	35·00	32·85	·98
1902	...	...	...	20·00	23·20	1·16
Total				55·00	56·05	1·02

POTOSI G.M.L. 450R.—The Potosi property has been worked by an underlie shaft. The reef has been worked to within about 25 feet from the surface from No. 1 level. There being no adequate plan of the property, a full description of the workings cannot be very well given.

Number 1 level has been driven north 420 feet and south 120 feet along the reef; number 2 level has been driven north 200 feet and south 49 feet. At this point the reef is only six inches in thickness. Number three level has been carried north 165 feet along the reef, which at the face is two feet six inches in thickness. The shaft has been continued 115 feet below number 3 level, and shows four feet of quartz.

The returns for this lease are included with those of the Mount Margaret Reward Claim, Ltd.

QUEEN OF THE MAY NORTH G.M.L. 524R.—There are three abandoned shafts on the property, but all are inaccessible. So far as may be judged by the dumps, the country rocks passed through is a foliated granite of the type prevailing in the district.

QUEEN OF THE MAY G.M.L. 466R.—There are three shafts on this lease. The most northerly shaft, which is now inaccessible, has been carried down 140 feet on an eastern underlie. This shaft had been sunk upon a reef which strikes N. 35° W. The shaft is used for the purpose of supplying water to meet the requirements of the Potosi Gold Mining Company. The mine yields water at the rate of between 6,000 and 7,000 gallons per diem.

As seen in the shaft down to 100 feet level, the reef consists of a zone of sheared granite, with thin veins of quartz parallel to the planes of schistosity. At a depth of 80 feet from the mouth of the shaft a crosscut has been put in to the east for about 30 feet through a pseudo-foliated granite. At 100 feet drives have been put in to the north and south for a distance of 100 feet each way.

The central shaft has been carried down to a depth of 110 feet; at 80 feet the reef consists of a very fissile and platy quartz. The water standing in this shaft is lowered by continued pumping in the ground to the north.

The southern shaft has been carried down to a vertical depth of 60 feet through granite country, but no reef has been discovered therein.

Crushings have been recorded from this mine during the years 1899, 1900, 1901, 1902, totalling 675·6 tons, with a yield of 658·2ozs. of gold, as follows:—

QUEEN OF THE MAY G.M.L. 466R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	14·60	31·00	2·12
1900	106·00	199·75	1·88
1901	300·00	170·00	·56
1902	255·00	257·45	1·01
Total	675·60	658·20	·97

QUEEN OF THE MAY SOUTH G.M.L. 467R.—The northern shaft on the lease has been sunk to a depth of 20 feet, and a drive has been put in to the south designed to intersect the open cut just alongside the shaft. About eight or nine inches of quartz of a somewhat fissile type is showing in the drive.

The central or water shaft has been carried down 100 feet vertically; at 90 feet a drive has been extended 80 feet northwards: in it there is about an average of 15 inches of quartz showing. About five feet of potable water is standing in the shaft. The southern shaft, which has been sunk on the same reef, has been carried down to a depth of 40 feet. From the foot of the shaft a drive has been put in along the reef to the north and connects with another shaft 38 feet in depth. At about 20 feet from the northern end of the drive is about 12 inches of platy fissile quartz of the usual type. About half way up this intermediate shaft the total width of the reef and formation is from 2 feet 6 inches to 3 feet. There have been officially recorded from this mine 1,191 ozs. of gold as the result of crushing 566·55 tons of quartz, as follows:—

QUEEN OF THE MAY SOUTH G.M.L. 467R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	16·55	33·00	1·99
1900	156·00	321·90	2·06
1901	231·00	666·00	2·37
1902	113·00	171·00	1·51
Total	566·55	1,191·90	2·10

PINDINNIE DEEP G.M.L. 463R.—This lease adjoins that last mentioned on the east. A vertical shaft has been put down (to an unknown depth) at the north-west angle of the lease through a micaless granite (4643). There is a little quartz of a very fissile type lying at grass; some of the quartz contained ribbons of felspar, suggesting the possibility of the quartz being merely a transmuted pegmatite vein. No work was going on at the time the lease was visited, hence a description of the workings cannot be given.

In 1900 the official records show that a crushing took place, but as it is included in the total of 125 tons yielding 157·6ozs. from the four leases 443, 457, 463, and 493, it is impossible to arrive at the exact amount of gold returned from this property.

G.M.L. 490R.—On this lease there is an underlie shaft 10 feet in depth, exposing a laminated quartz reef dipping at 41° to N. 60° E. The country rock on both the hanging and the foot walls is foliated granite of the usual type.

LITTLE WONDER G.M.L. 522R (a new lease embracing G.M.L. 461, Woomera).—An open cut 5 feet deep at the north-west angle of the lease shows the following section:—

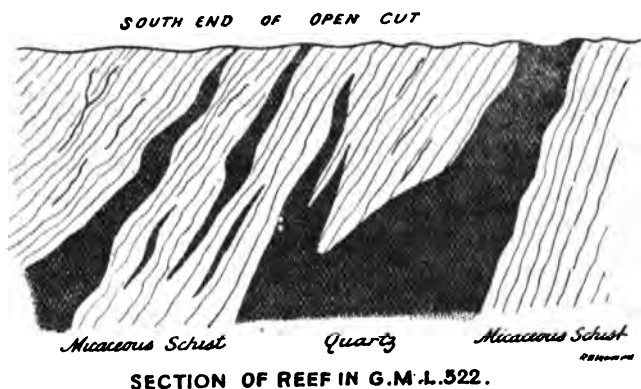


FIG. 15.

The quartz is enclosed in a micaceous schist, which may merely represent a transmuted granite.

At the northern end of the open cut, which is about 21 feet in length, there is only one foot of quartz exposed. The general strike of the quartz is south-east, and the underlie to the north-west at about 50 degrees. A fair quantity of quartz is lying at grass.

There are several shafts on the property and a good deal of work done, but, owing to the want of accurate plans of the workings, a definite description thereof is well nigh impossible. The reef is fairly well defined and naturally varies greatly in its size.

The returns for these two leases are as follow :—

WOOMERA G.M.L. 461E.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	58'00	28'85	49
1900	10'90	12'85	1'18
Total	68'90	41'70	60

LITTLE WONDER G.M.L. 522E.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	82'00	284'00	3'46
1902	197'00	839'86	4'26
Total	279'00	1,123'86	4'02

BOER G.M.L. 508E (originally Rich View, 462E).—This is a six-acre lease adjoining the south-east boundary of that last mentioned. A great deal of work has been done on this lease by previous holders of the ground, and the reef worked practically from the surface. The reef is a rockbound vein of quartz underlying at an angle of 45° to the east, and has been intersected by two vertical shafts, one 20 feet and the other 50 feet deep. At the foot of the 50 feet shaft the reef is about 12 inches in thickness. Coarse gold and pyrites is showing in a specimen (4646) from the foot of the 50 feet shaft.

A little distance to the south another shaft upon the same reef has been put down to a depth of 25 feet, but it only exposes about an inch or two of quartz.

According to the official figures several good crushings have been recorded from the lease, as follows :—

RICHVIEW G.M.L. 462E AND BOER G.M.L. 508E.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	74'00	226'80	3'06
1901	137'00	357'50	2'61
1902	62'00	207'00	3'33
Total	273'00	971'30	2'89

PENNYWEIGHT POINT.

The mining centre of Pennyweight Point lies east of Yundamindera, and due north of the trig. station ($\Delta 7208$) on Mt. Keith. There were only about four or five men at work at the date of my visit, hence very little could be seen. A good deal of dry-blowing must have been carried out at one period in the history of the district. The surface of the ground is covered with a shallow deposit of surface loam, beneath which is a relatively small thickness of aluminous laterite (? bauxite, 4642). The country rock seems to be diabase of the prevailing type.

The following is a description of those workings of which it was possible to make an inspection :—

LOMBARD G.M.L. 3349 (305R).—A vertical shaft 25 feet in depth had been put down near the northern boundary of W.R. 12 adjoining. This shaft exposes about three feet of laterite, which passes without abrupt line of demarcation into the underlying country. A drive has been put in from the bottom of the shaft for a short distance to the north-east; about 12 feet in the drive is a quartz reef underlying to the north-west at a low angle. The western side of the drive shows the following section :—

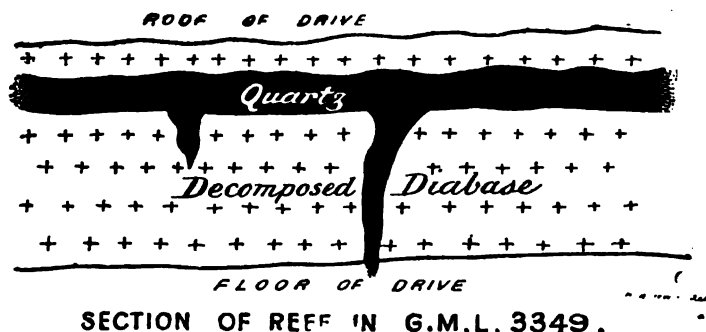


Fig. 16.

No work appears to have been carried out by the present occupants of the ground. The surface of the lease, however, is studded with numerous old abandoned shafts, giving silent testimony to the activity which at one time evidently prevailed.

HIGHLAND CHIEF G.M.L. 568R.—The Highland Chief workings are situated on the slope of a diabase hill, bearing 32° from W.R. 14R, and distant about a mile and a-half. The outcrop of the reef, which runs almost due east and west, can be followed for a considerable distance along the surface, and had apparently been opened up by previous occupants of the ground. The only accessible shaft at the date of my visit had been carried down to a vertical depth of 85 feet. At the foot was an east and west quartz reef underlying to the north at an angle of 55° . The reef had been opened out by drives put in to the east and west for a distance of

10 feet each way; in the eastern face the quartz reef attained a thickness of 3 feet 6 inches, and 1 foot 6 inches in the western. Free gold was showing in the quartz, which carried a small quantity of green carbonate of copper on the faces. At a vertical depth of 40 feet, the reef had been opened up 17 feet to the east, and a distance unknown to my informant, on the west. A crushing reputed to have yielded 29dwts. is said to have been obtained from this level. At the 20 feet level, a crushing is said to have averaged 16dwts. This property, which seems to have a good future before it, labours under the difficulty of having to cart the stone to Yundamindera, some miles distant, at a cost of 8s. 6d. per ton, and a charge for crushing rate varying from 25s. to 30s. per ton.

A.W.A. G.M.L. 562R.—The A.W.A. reef lies in close proximity to the Highland Chief. As seen on the surface the outcrop trends 109°. The property has been opened up by means of a vertical shaft sunk along the reef 90 feet deep.

WASHINGTON G.M.L. 594R.—The Washington is a reef upon which a good deal of work has been done at one time or another, but the workings were inaccessible at the date of my visit. The reef trends generally east and west, and underlies to the north. At the present time a deep shaft is being put down, and at the date of my visit had attained a depth of 115 feet. A crosscut is being put in to the south, at a depth of 100 feet, with the object of intersecting the reef at that depth. At the date of my visit the crosscut had only been driven 15 feet from the shaft. So far as may be judged by the stone in the outcrop, the stone of the Washington reef is free milling ore.

The following table shows the various crushings from these properties :—

GOLD YIELD OF THE YUNDAMINDERA DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
A.W.A. G.M.L. 562R.			
	tons.	ozs.	ozs.
1901	25'00	22'47	89
1902	165'00	762'30	4'62
1903 to 30th June ...	20'00	29'00	1'45
Total	210'00	813'77	3'87

BOER G.M.L. 508R (LATE RICH VIEW G.M.L. 462R).

1900	74'00	228'80	3'06
1901	137'00	357'50	2'61
1902	62'00	207'00	3'34
Total	273'00	793'30	2'90

**GOLD YIELD OF THE YUNDAMINDERA DISTRICT—
continued.**

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
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BOUND TO RISE G.M.L. 117E.

	tons.	ozs.	ozs.
Previous to 1897 ...	Unknown	240'00	...
1897	05	39'00	780'00
Total	...	279'00	...

BOOMERANG G.M.L. 538E.

1901	52'00	58'70	1'12
1902	69'00	69'95	1'01
Total	121'00	128'65	1'06

DEWEY G.M.L. 487E.

1900	134'45	240'10	1'78
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GEORGE WASHINGTON G.M.L. 111E.

1897	10'00	27'63	2'76
1898	72'75	173'40	2'38
1899	22'00	35'50	1'61
Total	104'75	236'53	2'25

GIOBIA G.M.L. 542E.

1901	40'00	14'75	37
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HIGHLAND CHIEF G.M.L. 673E.

1903 to 30th June ...	16'00	23'10	1'44
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GRANITE KING G.M.L. 550E.

1902	98'00	64'10	66
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JUST-IN-TIME G.M.L. 546E.

1901	109'00	59'00	54
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GOLD YIELD OF THE YUNDAMINDERA DISTRICT—
continued.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
LITTLE WONDER G.M.L. 522R.			
1901	82'00	284'00	3'46
1902	197'00	839'86	4'26
Total	279'00	1,123'86	4'03

LONDON AND HAMBURG GOLD RECOVERY Co.'s G.M.Ls. 443R, 457R, 463R, 493R.			
1900	125'00	157'50	1'26
1903 to 30th June ...	350'00	176'70	'50
Total	475'00	334'20	'70

MAORI QUEEN G.M.L. 541R.			
1901	70'00	125'00	1'78
1902	290'00	582'50	2'01
1903 to 30th June ...	20'00	28'00	1'40
Total	380'00	735'50	1'93

MT. MARGARET REWARD CLAIM, LTD., G.M.Ls. 450R, 456R, 536R.			
1899	76'00	170'00	2'23
1900	109'00	169'65	1'55
1901	4,718'00	3,636'54	'77
1902	2,784'00	2,580'10	'92
1903 to 30th June ...	1,243'00	853'10	'68
Total	8,930'00	7,409'39	'83

POTOSI NORTH EXTENDED G.M.L. 514R.			
	tons.	oss.	oss.
1901	116'00	173'50	1'49
1902	131'00	266'05	2'03
1903 to 30th June ...	59'00	118'00	2'00
Total	306'00	557'55	1'82

PRETORIA G.M.L. 511R.			
1901	35'00	32'85	'94
1902	20'00	23'20	1'16
Total	55'00	56'05	1'02

GOLD YIELD OF THE YUNDAMINDERA DISTRICT—
continued.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
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QUEEN OF THE MAY G.M.L. 466R.

	tons.	ozs.	ozs.
1899	14'60	31'00	2'12
1900	106'00	199'75	1'89
1901	300'00	170'00	'57
1902	255'00	257'45	1'01
1903 to 30th June ...	280'00	247'00	'95
Total	935'60	905'20	'97

QUEEN OF THE MAY SOUTH G.M.L. 467R.

	tons.	ozs.	ozs.
1899	16'55	33'00	1'99
1900	156'00	321'90	2'06
1901	281'00	668'00	2'37
1902	113'00	171'00	1'51
Total	566'55	1191'90	2'10

TE ANAU G.M.L. 121R.

1898	17'00	16'00	'94
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TUCKER BAG G.M.L. 499R.

1900	7'00	95'30*	13'61
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* Includes 13ozs. dollied and specimens.

TREASURE NORTH G.M.L. 549R.

1902	72'00	121'74	1'69
1903 to 30th June ...	36'00	101'23	2'81
Total	108'00	222'97	2'06

WOOMERA G.M.L. 461R.

1899	58'00	28'85	'49
1900	10'90	12'85	1'18
Total	68'90	41'70	'61

SUNDREY CLAIMS AT YUNDAMINDERA.

1898	137'00	189'30	1'38
1899	73'00	167'30	2'29
1900	39'00	17'90	'46
1901	30'00	14'30	'48
1902	202'00	418'01	2'06
1903 to 30th June ...	20'00	28'00	1'40
Total	501'00	834'81	1'66

EUCALPYTUS.

This all but deserted mining centre lies due east of Linde Mia (Pindinnie Soak).

A good deal of *bona-fide* work must have been carried out in the neighbourhood at one period of its existence; and so far as may be judged by the state of the surface a good deal of dryblowing must have been done. The productive area is embraced within the limits of about half a mile square. Practically no work was going on at the date of my visit, hence very little was to be seen. The following, however, is a description of those workings which it was possible for me to examine :—

LADY PASCOE G.M.L. 371.—An inaccessible shaft had been put down on a small quartz leader. In 1899, 10 tons from this lease yielded 4·32ozs. of gold, being at the rate of 48ozs. per ton.

G.M.L. 315 (SHANNON G.M. Co.)—An inaccessible relatively deep shaft had been put down at the south angle of the lease. On the surface at the south side of the shaft, two reefs trending respectively 298deg. and 269deg. outcrop. Very little work would seem to have been done on these. The following returns of the Shannon G.M. Co. were obtained from this lease, and M.A. 2E :—

SHANNON G.M. Co.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	164·00	65·50	·39
1900	22·00	60·20	2·73
Total	186·00	125·70	·67

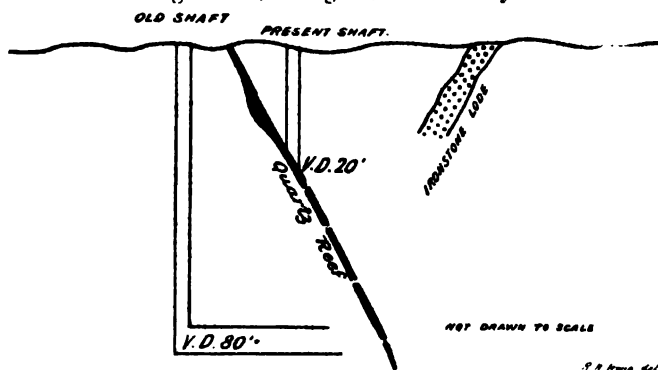
G.M.L. 398.—A water shaft had been sunk to a depth of 130 feet through diabase country, but no water was obtained.

G.M.L. 4480.—A good deal of work has been done upon the reef traversing this piece of ground. The reef first makes its appearance as a fine thread on the summit of the rising ground in the adjoining lease to the south, 367; and can be followed north-westward across the lease in the direction of 398.

Several shallow shafts have been put down at different points along the outcrop, but although some rich pockets have been met with, no serious attempt to systematically open up the reef would appear to have been made.

A vertical shaft, 80 feet in depth, had been put down by previous holders of the ground, apparently on the wrong side of the outcrop of the reef. The present holders of the ground have sunk a shaft 20 feet in depth. About 10 inches of quartz are exposed;

in the footwall is a rubbly ironstone leader, samples from which, in addition to showing coarse, free gold, dollied very well. The iron-



SECTION OF REEF IN G.M.L. 4480

FIG. 17.

stone leader, I am credibly informed, has been invariably observed to cut out at from 30 to 40 feet from the surface.

BROWN HILL REEF.—A little distance south of G.M.L. 385 is what is known as the Brown Hill Reef, which trends generally north-west and south-east. This reef, so far as may be judged by the number of disused shafts, must have been extensively worked by previous holders of the ground. The reef underlies at about one in one to the west; the accessible workings show that the quartz, which nowhere is very thick, occurs along a line of fault, both the hanging and the footwall sides of the vein being strongly slickensided.

About two miles to the north is the Shannon G.M.Ls. 958 and 3372 (Triumph North) which are now abandoned. The reef, which stands boldly out from the surface, forms a prominent landmark, and has a general strike of 35deg. The quartz reef, which is vertical, and several feet thick, is seamed with veins of a siliceous oxide of iron. (4641.)

Nowhere on the surface of the area does the cover of superficial deposits exceed six or eight feet in thickness. From what may be seen in the workings, costeans, etc., it is quite evident that the diabase is intersected by a net-work of quartz veins, in reality an auriferous stock-work, to the residual decomposition of which the rich dryblown patches may be ascribed. The richness of the superficial deposits, as well as the richness of the quartz reefs and leaders, would seem to afford good grounds for somewhat more systematic mining than would hitherto seem to have been in vogue.

The drainage from Fucalyptus flows north-east into Lake Carey, along several well defined water-courses. The rich residual deposits have led to prospecting in these valleys for deep leads, but so far nothing but a thin cover of wash resting upon rock decomposing in

situ in the direction of kaolin, has been met with. Between Eucalyptus and the lake some miles distant, the fall is very slight, and hardly sufficient to warrant the inference that the country is likely to develop an extensive system of deep leads.

GOLD YIELD OF THE EUCALYPTUS DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
BROWN HILL G.M.L. 491R.			
1900	tons. 7'00	ozs. *81'20	ozs. 11'60
1901	—	†31'91	—
Total	7'00	113'11	16'16

* Includes 22'05ozs. dollied and specimens. † Dollied and specimens.

CARDIGAN G.M.L. 538R.			
1900	7'00	150'00	21'43
1901	6'00	22'85	3'81
Total	13'00	172'85	13'29

CHESAPEAKE G.M.L. 442R.			
1899	10'00	7'00	7'0

CORNUCOPIA G.M.L. 520R (LATE 100R NINE OF HEARTS).

1898	520'00	718'87	1'38
1899	295'00	154'05	'52
1900	61'00	60'50	'99
1901	14'00	3'15	'22
Total	890'00	936'57	1'05

GOLDEN KING G.M.L. 530R.			
1900	—	*74'60	—
1901	2'00	29'85	14'92
Total	2'00	104'45	52'22

* Dollied and specimens.

IRONSIDES G.M.L. 426R.			
1899	60'00	25'35	'42

KEEP-IT-DARK G.M.L. 416R.			
1898	24'00	*204'50	8'52

* Includes 119'50ozs. dollied and specimens.

GOLD YIELD OF THE EUCALYPTUS DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom	Rate per ton.
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KNIGHT ERRANT G.M.L. 505R.

1900		tons 12 00	ozs. * 70 93	ozs. 5 91
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* Includes 48 60ozs. doliied and specimens.

LADY PASCOE G.M.L. 371R.

1899		10 00	4 32	43
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SCOTCHMAN G.M.L. 477R.

1899		* 2 35	* 110 70	47 10
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* Includes 65 45ozs. doliied and specimens.

SHANNON G.M. Co. G.M.L. 315R AND M.A. 2R.

1899		164 00	65 50	39
1900	... ..	22 00	60 20	2 73
Total	... ..	186 00	125 70	67

UNITY G.M.L. 400R.

1898	... ..	20 00	15 00	75
1900	... ..	3 00	6 00	2 00
Total	... ..	23 00	21 00	91

YANDO G.M.L. 504R.

1900	... ..	4 00	* 210 20	52 55
1901	... ..	15 00	† 974 40	64 96
1902	... ..	20 00	‡ 723 61	36 18
1903	... ..	—	§ 56 16	—
Total	... ..	39 00	1,964 37	50 36

* Includes 175 10ozs. doliied and specimens. † Includes 624 75ozs. doliied and specimens. ‡ Includes 452 86ozs. doliied and specimens. § Doliied and specimens.

SUNDRY CLAIMS AT EUCALYPTUS.

1898	... ..	54 00	51 00	94
1899	... ..	104 50	* 453 34	4 33
1900	... ..	12 00	† 115 50	9 62
Total	... ..	170 50	619 84	3 63

* Includes 332 52ozs. doliied and specimens.
† Includes 67ozs. doliied and specimens.

Leaving Yundamindera my route took me *via* French's Soak (Reserve 3387). The staple formation between the two places being granite of the usual type. About four miles to the north-east of the soak a vein of chalcedony has been opened up on the southern face of a low granite tableland. The matrix of the chalcedony is granite decomposing in the direction of kaolin. Several small veins of a chalcedonic breccia outcrop in the neighbourhood, but only upon one of them does any very great amount of prospecting appear to have been done. The vein is about six to eight inches in thickness, and has been followed down to a depth of about 10 feet. The chalcedony occurs in the form of irregular fragments along a joint or sheer plane. So far anything yet opened up is of little if any commercial value.

About a mile west of French's Soak the granite gives place to diabase (4648) which forms the summit of Mount Kildare, E52.

Between Mounts Kildare and Kilkenny, J.H.R. 19, the country appears to be all diabase. The summit of the latter peak is a fairly coarse-grained gabbro (4649, 4650).

MOUNT MALCOLM.

The Mount Malcolm neighbourhood is situated in diabase and allied rocks. At the date of my visit little or no mining was going on anywhere, and with one exception access to the underground workings was not obtainable; hence no description of the reefs and other cognate points is possible. The attached map shows the position of the various reefs so far as can be seen by careful inspection of the surface, and the following table of statistics shows the gold yields of the various properties.

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
ALICIA G.M.L. 388c.			
1897	tons 20'00	ozs. 40'38	ozs. 2'01

DEERAH G.M.L. 406c (631r).

1898	40'00	172'60	4'31
1899	63'00	224'90	3'57
Total	103'00	397'50	3'83

DOVER CASTLE G.M.L. 212c (4352).

1897	40'00	49'17	1'23
1898	119'00	159'73	1'34
1899	213'00	204'76	'96
1900	63'00	23'05	'36
Total	435'00	436'71	1'00

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—
continued.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
DUMBARTON G.M.L. 722c.			
	tons	ozs.	ozs.
1899	25'00	37'25	1'46
1900	111'00	136'55	1'23
1901	52'00	38'07	'73
1902	30'00	18'15	'65
Total	218'00	230'02	1'05

FLYING PIG G.M.L. 452c.			
1897	41'07	243'22	5'92
1898	90'00	152'33	1'69
1899	62'00	189'75	3'06
1900	69'00	120'15	1'74
1901	70'00	103'85	1'48
Total	332'07	809'30	2'43

GOLDEN CROWN G.M.L. 756c (4519).			
1899	52'00	57'20	1'10
1900	247'00	294'95	1'19
Total	299'00	352'15	1'17

GOLDEN PRIZE G.M.L. 33c.			
1898	17'00	21'97	1'29

GOLDEN SUNSET G.M.L. 355c.			
1897	'05	1'35	27'00
1898	186'00	332'72	1'78
1899	15'00	18'00	1'20
Total	201'05	352'07	1'75

GREAT BARRINGTON G.M.L. 568c.			
1898	19'00	8'65	'45

GWALIA BACH G.M.L. 459c.			
1897	30'00	50'10	1'67
1898	10'00	9'30	'93
Total	40'00	59'40	1'48

**GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—
continued.**

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
MAFEKING G.M.L. 773c.			
1900	tons. 16'00	ozs. 6'00	ozs. 37

**MALCOLM BELLE G.M.L. 576c (LATE SUNDAY,
146c).**

1897	28'00	32'93	1'17
1898	54'00	52'20	'96
1899	79'00	71'58	'90
1900	82'50	69'05	'83
Total	243'50	225'76	'82

**MT. MALCOLM GREAT NORTHERN REEF G.M.L.
717c.**

1899	50'00	23'00	'46
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MIDAS G.M.L., 637c (LATE MALCOLM MOHR, 147c).

1898	373'50	262'91	'73
1899	433'00	559'26	1'29
1900	370'80	643'05	1'73
1901	303'00	276'72	'91
1902	561'00	396'08	'70
Total	2,041'30	2,138'02	1'04

NORTH STAR G.M.Ls. 2c, 3c, 26c (3213).

1897	3,435'75	3,494'12	1'01
1898	1,144'00	1,197'04	1'04
1899	638'00	706'40	1'10
1900	5,076'00	4,784'15	'94
1901	2,352'00	2,248'25	'95
1902	1,233'00	2,227'07	1'80
Total	13,878'75	14,657'03	1'05

PRIDE OF THE NORTH G.M.L. 385c.

1897	5'30	54'00	10'19
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PIG AND WHISTLE G.M.L. 534c.

1898	36'00	43'10	1'19
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GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—
continued.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
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PRIMROSE DAY (MIDAS SOUTH G.M.L. 548c).

	tons.	ozs.	ozs.
1898	13'00	31'55	2'42
1899	17'00	23'30	1'37
Total	30'00	54'85	1'82

RICHMOND G.M.Ls., 12c (1196) 634c.

1897	16'00	36'95	2'27
1898	1,079'00	1,284'26	1'19
1899	786'00	836'44	1'08
1900	48'00	29'40	'61
1901	...	cy. 598'54	...
1902	603'00	459'95	'76
Total	2,514'00	3,244'94	1'29

SOUTH STAR G.M.L. 596c (530x).

1898	74'00	69'50	'93
1899	59'00	76'60	1'29
Total	133'00	146'10	1'09

SHOTOVER G.M.L. 580c.

1899	10'00	5'10	'51
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WHISPERING HOPE G.M.L. 617c.

1898	21'00	16'92	'80
1899	53'00	44'28	'83
Total	74'00	61'20	'82

KNARK G.M.L. 946c (770c).

1902	27'00	10'18	'37
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SUNDRY CLAIMS AT MOUNT MALCOLM.

1898	44'00	61'99	1'40
1899	6'00	12'71	2'12
1900	111'50	81'65	'73
1901	32'00	20'00	'62
1902	429'00	475'21	1'10
Total	622'50	651'56	1'04

SUMMARY.

One of the most noteworthy features in the country under examination is the occurrence of a continuous belt of iron-bearing cherts or quartzites, which has been followed for a distance of not less than fifty miles. There are strong reasons for believing that it extends northwards as far as Mount Morgans. The beds of which the belt is composed range from an almost pure quartz, through banded jaspers, often of great beauty, to what appears to the eye to be practically pure hematite. Analyses of the typical varieties of the different classes of ore showed that, contrary to their general appearance, they all contain a high percentage of silica, and a relatively low percentage of iron. Many of the deposits could readily be concentrated to high grade ores. Although the geographical position of the deposits puts them, under present conditions, beyond the reach of commercial enterprise, there is little doubt that were they more favourably situated as regards proximity to fuel, fluxes, or even water carriage, some of them might be turned to profitable account. Of the origin of the deposits it is difficult, with our present knowledge, to form any precise opinion. They are evidently not of elastic origin, occurring as they invariably do, in the greenstone schists; these have invariably been subject to a great amount of bleaching and decomposition in close proximity to the deposits. The greenstone schists contain a certain proportion of iron compounds in their composition, and the bleaching action in proximity to the quartzites would seem to imply that these form the source of the iron ore, and possibly that of the silica with which these ores are invariably associated. The iron-bearing quartzites occur in the form of attenuated overlapping lenses along what are evidently sheer planes of remarkable persistence, which, by virtue of their lamination, have formed channels for the more or less free circulation of mineral-bearing solutions.

On either side of the hematite-bearing belt numerous quartz reefs outcrop, and several mining centres—Yarri, Edjudina, Linden, Eucalyptus, etc.,—have been opened up, and so far as may be judged by the official statistics, a considerable quantity of gold has been won, though it is doubtful if all the gold actually obtained has been officially reported. In view of the extent of what may be termed the Edjudina-Yundamindera mineral belt, and the number of reefs actually outcropping in addition to those actually worked, there seem to me to be sufficient ground to warrant rather more vigorous prospecting than would hitherto have apparently been the case.

ERRATA AND ADDENDA.

NOTE.—The pagination is counted as one line.

Page 6, line 46, *add*—

Owing to exigencies of the public service, necessitating my presence in another portion of the State, it has not been found possible to devote any time to detailed petrographical descriptions of the various rocks embraced by this report. A great many sections have been cut with the view to microscopical examination, which it is hoped will be undertaken as opportunity offers.

Page 10, line 14, *for* "costeen" *read* "costean."

Page 10, line 15, *for* "costeen" *read* "costean."

Page 15, line 40, *for* "Bessemerprocess" *read* "Bessemer process."

Page 28, line 31, *for* "sheer" *read* "shear."

Page 58, line 30, *for* "sheer" *read* "shear."



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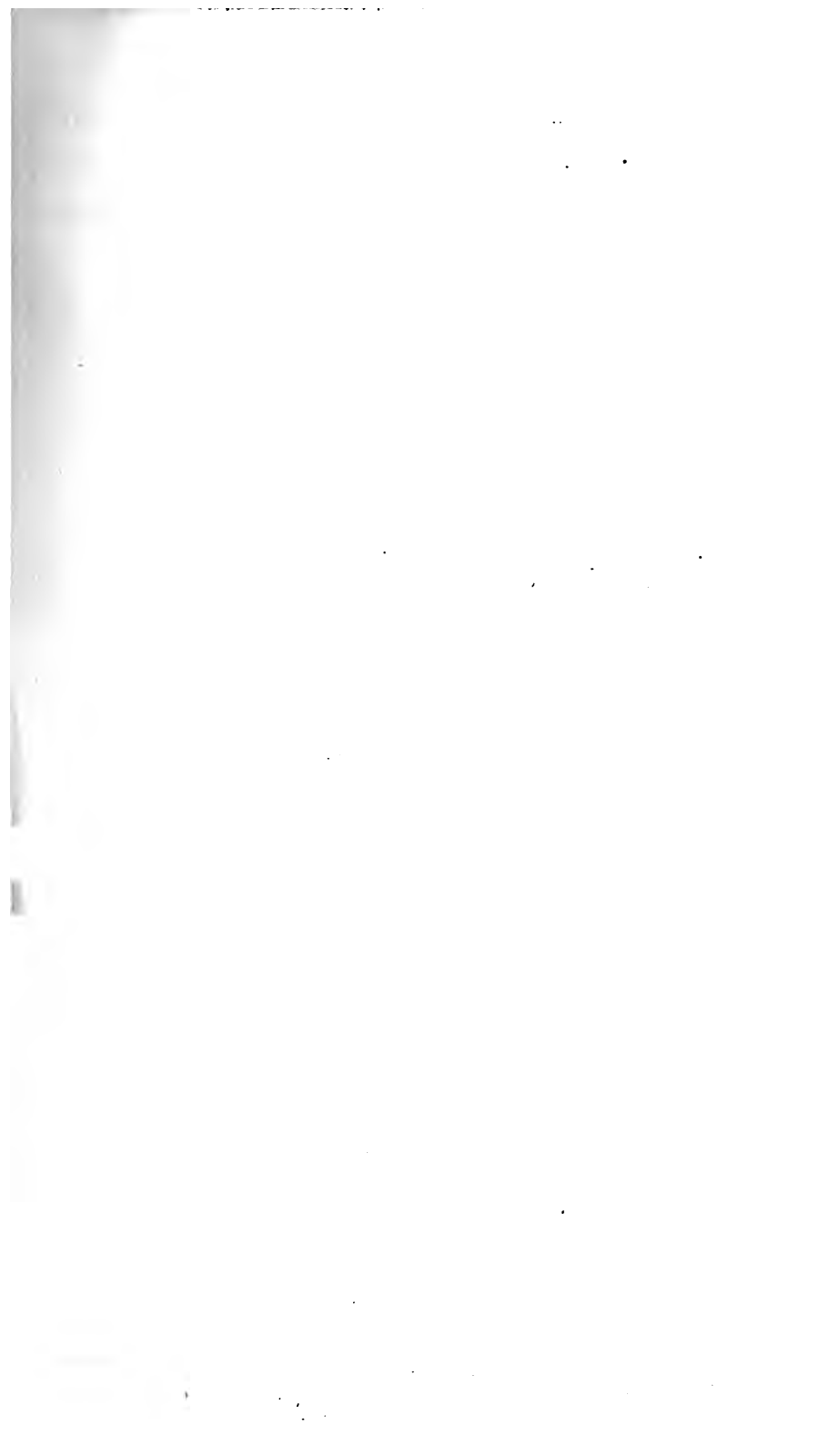
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1904.

WESTERN AUSTRALIA.

*With the Government Geologists
Compliments.*

GEOLOGICAL SURVEY.

BULLETIN No. 12.

THE GEOLOGICAL FEATURES AND MINERAL RESOURCES

OF

MULLINE, ULARRING, MULWARRIE,

AND

DAVYHURST,

NORTH COOLGARDIE GOLDFIELD.

BY

CHAS. G. GIBSON, B.E.,

ASSISTANT GEOLOGIST.

WITH TWO MAPS.

*Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.*



PERTH:

BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.

1904.

GEOLOGICAL MAPS AND REPORTS ISSUED BY THE GEOLOGICAL SURVEY OF WESTERN AUSTRALIA.

I.—MAPS.

- Geological Map of Northampton: by A. Gibb Maitland. Scale, 20 chains per inch. Price, 2s. 6d. 1898.
- Geological Map of the Collie Coalfield: by A. Gibb Maitland. Scale, 40 chains per inch. Price, 2s. 6d. 1898.
- Geological Map of Coolgardie: by Messrs. T. Blatchford and E. L. Allhusen. Scale, 10 chains per inch. Price, 10s. 1898.
- Topographical Map of Menzies: by W. D. Campbell. Scale, 20 chains per inch. Two sheets. Price, 2s. 1899.
- Geological Sketch Map of the country between Cue, Peak Hill, and Menzies, from the latest official information. Price, 1s. 1900.
- Topographical Map of Kalgoorlie: by W. D. Campbell and S. J. Becher. Scale, 10 chains per inch. Four Sheets. Price 5s. 1900.
- Mining Map of the Boulder Belt: by W. D. Campbell. Scale, 4 chains per inch. Two sheets. Price 5s. 1900.
- Geological Map of the North Lead, Kanowna: by Torrington Blatchford. Scale, 8 chains per inch. Price, 1s. 1901.
- Geological Map of Kalgoorlie: by a Gibb Maitland and W. D. Campbell. Scale, 10 chains per inch. Six sheets. Price, 21s. 1902.
- Geological Map of Lennonville: by A. Gibb Maitland and C. G. Gibson. Scale, 15 chains per inch. Price, 1s. 1902.
- Geological Map of the Boulder Belt and Sheet of Horizontal Sections: by A. Gibb Maitland and W. D. Campbell. Scale, 4 chains per inch. Three sheets. Price, 12s. 6d. 1903.

II.—REPORTS.

Reports by the Government Geologist in connection with the Water Supply of the Goldfields (price, 2s. 6d.), containing—

- (a.) Proposed Boring for Artesian Water on the Coolgardie and Kalgoorlie Goldfields.
- (b.) Possibility of obtaining a Supply of Artesian Water at Menzies.
- (c.) Cue Water Supply for Crushing Purposes. 1897.

Annual Reports. Price, 2s. 6d. each:—

1. Progress Report for the Year 1897, containing—

Ferruginous Conglomerate at Coates Siding; Geological Features and Mineral Resources of Northampton; Country between Northampton and Peak Hill; Geology of the Peak Hill Goldfield; Horseshoe Diggings; Artesian Water; Fumes from Fremantle Smelting Works; Native Tellurides of Gold; Mineralogical and Petrological Notes; So-called Deep Lead at Kanowna; The 25-Mile Cement Leases; Coolgardie Goldfield. (*Out of print.*) 1898.

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PREFATORY NOTE.

HE examination of Mulline, Ularring, Mulwarrie, and Davyhurst was primarily undertaken with the object of showing the mutual relationship of the Auriferous Series at these different localities. The results of this investigation are shown on the maps, prepared by Mr. Gibson, which are correct so far as the scale of the field plans employed would permit. The ground embraced by the work covers an area of about 174 square miles, and includes all the important mining centres.

The staple formation of the district, apart from the extensive cover of the ubiquitous superficial deposits, is made up of a complex of hornblende rocks ("Greenstone"), which form the auriferous series, conforming in this respect to the other fields so far examined. The series form a belt of ten or more miles in width, and probably some 150 miles in length. There seem to be good grounds for believing that this forms part of the belt which includes Coolgardie, 90 miles to the south, and Mount Ida, 54 miles to the north; thus proving a known auriferous belt of 144 miles in length, along which it would not be unreasonable to anticipate the occurrence of other deposits quite as rich as any of those already opened up.

The hornblende rocks are intersected by biotite-granite, from which dykes attaining a thickness of 30 or 40 feet emanate. Some of these have been followed across country for several miles, and in one instance a dyke has been worked for its gold contents.

The quartz reefs, though with one or two exceptions small (and when worked below water level contain large quantities of sulphides), seem on the whole to be well defined, and give every promise of being permanent.

The report is accompanied by schedules of gold returns, compiled from the latest official statistics, which demonstrate that, from the area embraced by Mr. Gibson's work, there have been raised, up to the end of 1902, 73,625·83ozs. of gold from the crushing of 44,788·91 tons of quartz, thus giving an average of over one and a-half ounces of gold to the ton.

With the advent of systematic scientific mining, together with the erection of suitable machinery, there seems every reason to believe that the district will show a marked increase in its gold output in the future.

So far as the origin of the gold is concerned, it is quite clear that in the Ularring District the deposition of the gold took place after the intrusion of the granite, at whatever geological period that occurred.

The district is, as a whole, well-timbered, though not particularly well watered ; this condition of affairs might be overcome by either surface conservation or well-sinking.

The report and explanatory maps, being submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

A. GIBB MAITLAND,

Geological Survey Office,

Government Geologist.

Beaufort Street, 20th January, 1904.



The Geological Features and Mineral Resources

OF

MULLINE, ULARRING, MULWARRIE, & DAVYHURST.

Boundaries of the Field.—The North Coolgardie Goldfield was proclaimed on 29th May, 1895. It had its boundaries altered on 12th March, 1897, and at present embraces an area of 30,609 square miles, which, according to authorities, is bounded :—

“By lines starting from the southernmost corner of the Murchison Goldfield, being the south-west corner of the East Murchison Goldfield, and situate about twelve miles east and five miles south from trig. station K.75 on Wyemando Hill, and extending south to the south-east corner of the Yalgoo Goldfield, which is a point due east from Mount Gibson, near Lake Moore, and due north of a spot ten miles west of a cairn on Yorkrakine Granite Rock; thence east-south-east to a point about fifty miles due west from a cairn marked N.B.1, near Wangine Soak; thence east to survey station N.B.1; thence about 87° twenty miles twenty-two chains to survey station R.3; thence east to the 125th meridian east longitude; thence north along that meridian to a point east of a tree marked B.82 at Brickey's Soak; thence west through the said tree to a spot about 76½ miles west from it, and thirteen miles north and fifteen miles east from the summit of Mount Ida; thence north about thirty-one miles to the south boundary of the East Murchison Goldfield, and west to the starting point.”

This field, which originally formed part of Coolgardie, and from which it was divided owing to the discovery of many rich reefs around Menzies, and the rapid increase of population, has, for purposes of administration, been subdivided into the Menzies, Ularring, Niagara, and Yerilla districts.

History of the Field.—Nothing official has been recorded of the history of the North Coolgardie Goldfield.

Previous Observations on the Geology of the Field.—Beyond a short report by Mr. Woodward * on the Mount Ida district, nothing official has been written about the geology of the field.

* Annual Progress Report of the Geological Survey, p. 12, 1901. By Authority: Wm. Alfred Watson, Government Printer, Perth.

The Extent of the Map.—The area which has been mapped and depicted on the plan embraces an area of about 174 square miles, and includes the mining centres of Riverina, Mulline, Ularring, Mulwarrie, and Davyhurst. The map makes no pretensions to absolute accuracy, except in the near vicinity of the mining leases, the nature of the country, and the absence of any distinctive hills or landmarks rendering accurate work almost impossible at any distance from the lease pegs, that is, with the means—compass and plane table—and time at my disposal.

General Description of the Country.—The country generally consists of level plains covered with a considerable thickness of recent superficial deposits, through which rise low rough greenstone hills and ridges, and bare outcrops of intrusive granite. These greenstone ridges are especially numerous in the Riverina district, where they rise to a height of about a hundred feet, trending northwards beyond the limits of the map and then away slightly west of south past Mulline and Ularring to a point some four miles south-south-west of the latter place, where they die out below the alluvium of the plains, re-appearing again about a mile north of Mulwarrie and running south through this place and on towards Callion beyond the southern boundary of the map. Eastward from Mulwarrie towards Davyhurst the country is uniformly flat, the greenstones outcropping here and there, but being for the most part covered with superficial deposits varying in thickness from a few inches to many feet. The hills and ridges are often covered with a capping of considerable area of ironstone gravel.

Intruded into the greenstones in several places are large masses of granite. These occasionally outcrop as low bare hills, of which the Ularring Rocks are a typical example, but more often are found to be covered to a considerable depth with loose sandy soil resulting from their own weathering.

The greenstones are bounded on the west by a belt of intrusive granite, which rises as a low north and south ridge of hills some six or eight miles west of Mulline. Intermediate between these hills and the greenstone ridges of Mulline and Ularring is a considerable extent of sandy flats, which, from their general appearance, are probably overlying granite, and which are thickly covered with spinifex and stunted mulga.

Numerous dykes of acid eruptive rocks are found intersecting the greenstones in all directions, especially in the neighbourhood of Mulwarrie, where, however, their prevailing strike is north-west and south-east, and where they can be followed across country for some miles.

The belt of greenstones, which forms the auriferous series has a general north and south trend, and is at the least some eight or ten miles in width, and is probably the same belt in which the auriferous deposits of Coolgardie and Mt. Ida are situated.

Recent Superficial Deposits.—These are of two kinds:

(a.) The loose incoherent material which is found covering the greater portion of the district, and (b.), the nodular ironstone gravels. Of these, the former is of very considerable extent, covering the flats and low-lying country to a depth of from a few inches to 50 or 60 feet; it is the result of the gradual weathering of the older granite and hornblende rocks, and where found overlying the former is much lighter in colour, looser, and more sandy, and is generally covered with spinifex and stunted mulga. The nodular ironstone gravels, or laterite deposits, usually occur as the cappings of hills and ridges, and are of much more limited extent. Deposits of this kind are found throughout the State, and have been thus described by Mr. Simpson* in Bulletin VI. of the Geological Survey:—

“These, with the gravels resulting from their denudation, are the most widely distributed iron ores in the State, but are unfortunately the most erratic in quality, varying from a ferruginous bauxite or claystone to an almost pure limonite or turgite. The structure is sometimes massive and almost homogeneous, but it is more frequently pisolitic or nodular, in which cases the concretions are richer than the interstitial matter. Occasionally the ore is cellular and streaky in colour whilst still more rarely it appears brecciated, the angular fragments then consisting of almost pure hematite or limonite. They are invariably found as superficial deposits overlying granite, diorite, or amphibolite, or chlorite schists derived from them. They are most largely developed on the caps of the hills or ranges but in many cases follow down the sides of the hills parallel to the undulations of the bed rock, from which they are not separated by any hard and fast line. In depth they pass gradually into such highly ferruginous rocks as the diorites of the Darling Range, or the amphibolites and chlorite schists of the interior. At Kalgoorlie, cappings of very rich laterite occur on some of the hills underlaid by clays now poor in iron, from which the iron was originally derived, for it represents the result of decomposition *in situ* of highly ferruginous amphibolite. At Darlington and elsewhere they are found to overlie granite as well as diorite or other basic rocks, but never far from the latter. They can, in every case, probably be accounted for by the concentration of the ferric oxide resulting from the surface decomposition of rocks rich in iron.”

Hornblende Rocks (Greenstones).—These rocks, which comprise the auriferous series, and to which the general term “Greenstone” has been applied, consist principally of a very fine grained diorite, passing in places into a coarse-grained variety, as well as an indefinite somewhat foliated rock, which is probably only an altered form of the former, and are for the most part very decomposed and weathered to a depth of from 150 to 180 feet. In the neighbourhood of the Riverina leases these rocks outcrop as rough ridges, and are but very little decomposed: they are massive

*Geological Survey of W.A. Bulletin No. 6, page 36, 1902. By Authority: Wm. Alfred Watson, Government Printer.

with no signs of foliation, and are of both the fine and coarse-grained varieties; between these there is no hard and fast boundary, and they are evidently merely different forms of the same rock. South from the Riverina, past Mulline and Ularring, they are all of one class, consisting of a fine-grained, massive diorite. At Mulwarrie and its vicinity they are again of the two varieties, the fine-grained predominating however. There are also one or two small areas in this locality over which the rocks are somewhat foliated, the foliation running parallel to, and being apparently due to the presence of, numerous granite and felsite dykes, which run through the greenstones here in a general north-west and south-east direction.

At Davyhurst again they are entirely of the fine-grained variety, but are considerably more foliated here than in any other part of the district. At one spot, about three-quarters of a mile west of Davyhurst township, they have been altered for a width of about two chains, probably by pressure due to faulting, into highly inclined actinolite schists. This belt of schists runs on a bearing slightly west of north and east of south, and can be followed across country for some distance, gradually passing on either side into unaltered fine-grained diorite.

Sections of each of these varieties of diorite show them, when examined under the microscope, to consist essentially of pale-green hornblende and triclinic felspar, with magnetite in small grains scattered through the section, the hornblende and the felspar being present in about the ratio of 3 to 2; the only difference between the two rocks being in the size of their component crystals.

This belt of greenstones is at the least more than eight miles across, and is probably the same belt in which the auriferous deposits of Coolgardie and Mount Ida are situated.

The junction of the greenstones and the granite is for the most part hidden by the superficial deposits, but where it can be seen the greenstones are found to be highly foliated and contorted, the lines of foliation being parallel to and dipping away from the line of the granite; small patches of foliated greenstone are often found caught up in the granite.

Granite.—Bounding the greenstones on the western side, and intruded into them in several places within the district mapped, occurs massive granite. This is of a fairly coarse-grained biotite variety, hornblende being, as far as could be seen by microscopic examination, almost entirely absent. It outcrops only in isolated cases, usually as low bare hills, being for the most part covered with its denuded remains, principally sand. A section cut from a specimen taken from the Ularring Rocks at trigonometrical station N.B. 9, and seen under the microscope, shows it to consist of:—

- (a.) Quartz.—Abundant in large irregular lumps and grains, and containing numerous inclusions.

- (b.) **Felspar.**—Very abundant, occurring as large irregular grains and imperfectly formed crystals; it is principally of the monoclinic variety, though a little plagioclase is present as well as a fair amount of microcline.
- (c.) **Biotite.** Present in brown tabular crystals, but not very abundant.
- (d.) **Hornblende.** Present in small dark green crystals, but only in very small quantity.

The rock is somewhat decomposed.

Acid Eruptive Dykes.—Intersecting the greenstones in many places are eruptive dykes of acid rocks; these vary in size from a few inches to 30 and 40 feet, and run in all directions; the more general strike of them, however, being about north-west and south-east. They are especially numerous in the neighbourhood of Mulwarrie, where they can be traced through the greenstones on a general north-west and south-east bearing for several miles. They are closely allied to and are probably connected with the main intrusive masses of granite. Microscopic examination shows them passing through all gradations, from a very coarse granite to exceedingly fine-grained compact felsites and quartzites. These dykes are more recent than the quartz reefs of the district, and are found in several instances cutting right through the latter, and as a rule without having any effect on their strike, dip, or gold contents. In one instance—at the Thunderbolt G.M., Mulwarrie—one of these felsite dykes itself is being mined; this is partly due to the presence of small quartz stringers running through the rock, forming a class of stockwork, and also to the presence of a fairly large body of quartz running alongside the dyke. Only the quartz and the stockwork are being worked, the dyke rock itself, when free from quartz, carrying no, or at most only a trace of, gold.

REEFS AND LODES.

Lodes.—Only a few instances of auriferous lodes are met with in the district, and as such they occur in intimate connection with the quartz reefs, and are usually found associated with numerous quartz stringers and veins and occasionally with large bodies of quartz; in some cases it being difficult to say whether they should be classed as lode formations or as quartz reefs. In appearance they differ only from the country rock in that they are usually more highly foliated and much softer, and generally traversed by small quartz veins. They have no defined walls, their boundaries, both horizontally and vertically, being determined solely by the decrease in the assay value of the stone. Speaking of the lode formations of Western Australia,* Mr. Simpson, in Bulletin 6 of the Geological Survey, says:—“A ‘lode formation’ may be defined as

*Geological Survey, W.A., Bulletin 6, p. 22. By Authority: Wm. Alfred Watson, Government Printer, 1902.

a more or less vertical zone of rock, usually continuous with the surrounding rocks, and of similar origin, but distinct from it in carrying metallic ores disseminated through it in payable quantities, and, as a rule, characterised by strong foliation. Deposits of this nature are probably deep-seated; at Kalgoorlie, mining operations have already proved their persistence to 1500 feet below the surface. The typical lode formations probably owe their origin to a shearing action having crushed and foliated portion of the rock mass in a certain definite direction, producing a more or less well-defined band of rock through which, by virtue of the foliation, mineral bearing solutions or vapours can have free circulation. In consequence of this, mineral deposits are formed within the rock, usually, but not necessarily, extending over the whole of the foliated zone, but seldom beyond it, and having no definite boundaries, horizontally or vertically, other than those determined by the decrease of the assay value of the rock in any one direction to a point at which it ceases to pay the expenses of working."

Quartz Reefs.—These are found to vary considerably both in size and in the direction of their strike. The prevailing trend, however, is slightly west of north and east of south, though reefs with an almost due east and west strike are being profitably worked at the Mulline and Cooladdie mines, Mulline; the east and west reefs, however, are generally smaller and more irregular than the north and south ones. On the whole all the reefs in the district may be said, with one or two exceptions, to be small; they are, however, generally speaking, regular and very well defined, and give every promise of living to a considerable depth. Wherever worked below water level they have been found to be highly charged with sulphides; this also very often happens long before water level is reached, for example, the Lady Florence G.M., Mulline, and the Homeward Bound G.M., Mulwarrie. The gold both in the reefs and lodes is generally found to occur in chutes, the length of these chutes being, roughly speaking, from 150 to 300 feet.

Water.—The district as a whole is not particularly well watered. A good supply of fresh water can, however, usually be obtained during the winter months from the soaks at the Mulline, Cooladdie, and Ularring Rocks; this supply, however, depends on the rainfall, and generally gives out before the end of the summer. Fresh water has also been struck in two or three of the mines, viz., the Riverina mine at 160 feet, the Redleap mine, Ularring, at 135 feet, and the Mulwarrie mine, Mulwarrie, at about 160 feet. Water fit for stock purposes has been also met with in the Mulwarrie Main Reef mine, Mulwarrie, at a depth of about 120 feet. Generally speaking, however, the water supply of the district is salt, and, being unfit for domestic purposes, necessitates the use of extensive condensing plants. So far the supply in the mines is not known, as the majority of them have not carried their workings below water level, and no pumping is being done.

The following are the depths and the daily supplies from the Government wells in the district:—

Mulline State battery well, depth 130 feet, 13,000 gallons, carrying 1·18 per cent. of solids.

Mulwarrie State battery well, depth 160 feet, 4,000 gallons, carrying about 5 per cent. of solids.

Mulwarrie Government well, depth 158 feet, 4,080 gallons, carrying 2 per cent. of solids.

Davyhurst Government well, depth 137 feet, 1,200 gallons, carrying 2 per cent. of solids.

The water in each of these wells is salt, but at both State batteries it is suitable for, and is being used for, both milling and cyaniding purposes.

Timber.—The district as a whole is well timbered, such being especially the case in the vicinity of Mulwarrie and Davyhurst, where the low-lying flats are covered with a heavy growth of mulga, gimlet, and white gum.

THE MINES.

The following is a brief description of the principal mines working in the district at the time of my visit, June, 1903:—

Mulline District.

RIVERINA G.M.L., 123v.—There are a number of shafts on this property working on a fair-sized north and south quartz reef, which runs through the lease near its western boundary; the deepest of these is down about 160 feet. A main winding shaft has been sunk vertically to a depth of 200 feet about two chains to the east of the reef, and crosscuts put in to cut the reef at 100 and 200 feet. Levels have been driven along the reef at 80, 160, and 200 feet; that at 200 feet has been put in some 40 feet north and the same distance south from the main crosscut; no stoping has been done at this level; at 160 feet the drives extend 130 feet south and 50 feet north, whilst at 80 feet the total length of driving is about 300 feet, and for the whole of this length the reef has been stoped out to the surface. A short intermediate level has been put in at 120 feet, and a small amount of stoping done.

The reef consists of white quartz with varying thicknesses of schistose formation between it and the walls; this formation, as a rule, only carries a very small quantity of gold. The stone varies in size from one to three feet, the quartz being found at one time on the hanging-wall and at another on the foot-wall; the walls are clean and very sharply defined and run absolutely vertically, the distance between them averaging about four feet. The chute of gold at present being worked dips to the south at a steep angle. The country is soft down to about 160 feet, where it becomes very hard and settled; at this point sulphides begin to come in, and are fairly abundant at water level.

Fresh water was struck at about 165 feet.

Two other lines of reef run through this property; one is a short north-east and south-west reef, which outcrops near the centre of the lease. This, as far as tested, has proved to be entirely destitute of gold. The other is a north and south reef, which runs into the lease from the south near its western boundary. The only work done on this reef on this property consists of a shaft sunk to a depth of about 30 feet. The reef is about two feet wide, and is expected to average about 15dwts. The main line of reef has been proved through the entire length of the lease, and also for a considerable distance into the adjoining property on the north, where it has been worked to a depth of about 130 feet. Near the southern boundary of the Riverina it is cut off by an east and west fault, and thrown about 60 feet to the eastward. From this point southward its course is not so regular, it gradually turning away easterly as it runs through the adjoining lease (the Riverina South).

This property has crushed, up to the end of 1902, 5954·00 tons for 4,068 59ozs., giving an average of ·68ozs. per ton, the gold being worth £3 12s. 6d. per ounce.

RIVERINA SOUTH G.M.Ls. 324v, 600v.—The main line of reef at present being worked on this property is a continuation of the Riverina reef; as above stated, its course through this property is not so regular, the reef having a gradual trend away to the eastward. It has been worked to a vertical depth of about 130 feet on this property, and a considerable amount of stone taken out.

A second quartz reef is at present being prospected near the eastern boundary of the lease; this is a small reef running north and south, on which a shaft has been sunk to a depth of about 50 feet.

The stone crushed from these leases to the end of 1902 is 2,523·00 tons for 2,204·38ozs., being at the rate of ·87ozs. per ton.

MULLINE G.M.L. 2v.—On this property a small quartz reef is being worked; the reef runs east and west, and dips at an angle of about 12° to the north; it varies considerably in size, ranging from a mere thread to as much as two or three feet; its average width is about 12 inches; the dip also varies a good deal.

A little to the east of the main line of shafts the reef is cut off by a fault which runs slightly to the east of north, and dips at a fairly steep angle to the westward; no extension of the reef has so far been found beyond this fault. Several north and south faults cross the reef farther west, it in each case being thrown downward for a few feet, and also slightly to the west.

The country is soft decomposed greenstone.

A large quartzite dyke runs north and south through the lease some 50 feet to the west of the main line of shafts cutting through the reef, without, however, displacing it at all. Several shafts have been sunk to cut the reef, the most northerly or main

hauling shaft being down 90 feet vertically, thus being the deepest vertical shaft in the property. The reef itself has been followed on the underlay for a distance of slightly over 600 feet from the surface. At 300 feet, levels have been put in east and west for 40 feet each way, and stoping carried up to the surface for this length. Practically no driving or stoping has been done below this level.

A second small east and west reef outcrops close to the southern boundary of the lease; a good deal of work appears to have been done on it, but it is now abandoned.

The whole neighbourhood is full of small quartz reefs, all carrying gold, but not of sufficient size to pay for working.

Total stone crushed to the end of 1902 is 899·25 tons for 1,384·85ozs., being at the rate of 1·54ozs. per ton, the gold being worth £3 13s. 6d. per ounce.

COOLADDIE G.M.Ls. 338v, 408v.—The reef being worked on this lease is also an east and west one, with a very flat dip of 9° to the south. The lode consists of a quartz reef averaging about 12 inches in width, together with about two feet of schistose formation, which, as a rule, only carries a slight trace of gold, and is generally discarded. The quartz is found sometimes on the hanging-wall and sometimes on the foot-wall, and varies in size from 9 to 18 inches. The length of the chute of gold at present being worked is about 200 feet.

Several shafts have been sunk to cut the reef, the deepest being a little over 100 feet vertical. An underlay shaft has also been sunk on it for a distance of nearly 700 feet from the surface. At 600 feet, a level has been put in east for a distance of 50 feet, and the reef stoped out for this length up to 250 feet, and from this level to the surface for a distance of 150 feet east and 60 feet west.

The country is fine-grained greenstone, very soft and decomposed in the upper levels, but getting harder towards the bottom workings. No water has been met with, so far.

This mine has crushed, up to the end of 1902, 2,073·50 tons for 3,197·36ozs., giving an average of 1·54ozs. per ton, the gold being worth £3 12s. 6d. per ounce.

LADY FLORENCE G.M.L. 403v.—Two large quartz reefs run through this property in a north-west and south-east direction. On the most western of these three shafts have been sunk, two of which are now in use; of these, the deepest is down 120 feet, of which 80 are vertical, 20 underlay, and 20 vertical again, whilst the other is down 100 feet, 50 vertical and 50 underlay. Levels have been driven along the reef for about 100 feet at the 100 feet level and a little stoping done, while a good deal of driving and stoping has been done between this and the surface. The reef consists of white quartz averaging four feet in width, and has clean, sharp greenstone walls. The stone is very heavily mineralised from 100 feet down.

The second reef is about three chains farther east, and runs approximately parallel. Several shafts have been sunk on it, but only to a depth of about 40 feet, and practically no work has been done on it. The reef, where cut at 40 feet, is about 12 feet in width, and dips slightly to the east; the quartz is white, considerably broken, and ironstained.

This property has crushed, to the end of 1902, 631.25 tons of stone for a yield of 463.98ozs. of gold, being at the rate of .73oz. per ton.

LADY GLADYS G.M.Ls. 139v, 235v, 555v.—The original workings on this property were situated on a mass of highly decomposed greenstone immediately underlying a capping of ironstone gravel; a little quartz is disseminated throughout the mass in fine veins and stringers, and the whole over an area of about half an acre was highly auriferous. This was worked out down to a depth of about 30 feet when the gold suddenly gave out. At this point a small, very flat quartz reef was picked up. This reef was here about six inches in width, and dipped west at an angle of about 15 degrees. At the spot where first picked up it seemed to have been cut off to the north by an east and west fault as no continuation of it was found to the northward. The gold in the decomposed greenstone probably owed its existence to the presence of this reef, which was here exceptionally rich. The reef continues on its westerly dip of 15 degrees for about 40 feet, when the dip suddenly changes to about 35 degrees for 15 or 20 feet, and then back again to the original 15 degrees. In the lower workings the dip of the western reef gradually changes, and in the bottom level is about south-west instead of west. Just about the main line of shafts the reef takes another sudden change, and dips away steeply to the eastward. This eastern arm is somewhat smaller than the western, and as far as tested is practically free from gold. The size of the western arm varies from about 12 inches in the upper levels to about $2\frac{1}{2}$ feet at the bottom levels. It has been worked out on the underlay to a vertical depth of about 150 feet. Several shafts have been sunk along the line of the cap of the reef, whose general trend is about north-west and south-east, and these have been connected by a main drive and the reef stoped out for a width of about 70 feet west of the line of shafts. The quartz is very heavily charged with pyrites below 110 feet, at which point the country begins to get very hard and compact.

The adjoining leases on the east are working small north and south quartz leaders. These dip to the east and are very rich in places.

Total stone crushed to end of 1902 is 5,915.00 tons for 14,347.71ozs., including 186.73ozs. dollied and specimens; giving an average of 2.42ozs. per ton, the gold being valued at £3 17s. 7d. per ounce.

SHAMROCK G.M.L. 1v.—A small quartz reef runs through this lease, near its western boundary, on an almost due north and south bearing. Several shafts, all underlay, have been sunk on it, the deepest to a depth of 130 feet, and a good deal of work has been done. The reef is about 18 inches in width, and dips at an angle of about 60 degrees to the east. It has been stoped out from 130 feet to the surface for a distance of about 200 feet; from the surface down to 40 feet the gold contents were rather poor, but from this point down they averaged from 30 to 40dwts. The chute of gold is about 200 feet in length, and dips to the south. The country is fine-grained greenstone, and on the foot-wall at 130 feet is fairly hard and settled; on the hanging-wall it is much softer and more broken. No water has been met with, so far.

This mine has crushed, to the end of 1902, 1,009.25 tons for 1,623.08 ozs., giving an average of 1.61 oz. per ton.

Table showing Gold Returns from Leases in the Mulline District, other than those already mentioned, up to the end of 1902.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Acrobat	327v	55.67	85.50	1.53
Ajax	501v	257.75	296.85	1.15
Albury	74v	25.00	66.90	2.67
Anastasia	552v (243v)	20.00	9.90	.49
Argentina	450v (357v)	148.00	67.80	.46
Belle Mai	179v	925.00	1143.57	1.23
Boer	446v	11.00	5.00	.45
British Lion	162v	68.30	78.75	1.15
Chamberlain	330v	107.00	118.40	1.10
Cocas	433v	34.50	46.50	1.34
Comet	601v	72.00	63.80	.89
Cora	553v	36.25	136.54	3.77
Chiltern	448v	34.50	19.05	.55
Dawn	362v	30.00	19.50	.65
Day Dream	206v	10.00	2.10	.21
Day Dream South No. 2 Extended	314v	81.00	94.75	1.17
Dismissal	688v	22.00	13.64	.62
Don Juan	353v	72.50	76.30	1.05
Duchess of York	603v	134.00	79.07	.59
Dungan	340v	156.50	101.40	.64
Exchange	542v	7.00	11.75	1.67
Golden Lode	350v	13.50	23.60	1.74
Gold Standard	435v (315v)	248.00	255.32	1.03
Great Expectation	483v (385v)	55.00	9.90	.18
Hornet's Nest	635v	3.50	7.70	2.20
Karrakatta	575v	12.00	89.50*	7.46
Lady Gladys Junction	670v (290v)	902.00	852.48	.94
Le Grand	534v	7.00	6.60	.94
Marvellous West	328v	158.00	159.85	1.01
Monarch G.M. Co.	451v (95v)	390.00	373.19	.96
Mikado	528v	19.00	21.25	1.11
Mulline Commonwealth	704v (206v)	51.00	27.61	.54
Mulline Rose	595v	31.50	18.08	.57

* Includes 12.05ozs. dollied and specimens.

Table showing Gold Returns from Leases in the Mulline District, etc.—continued.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Mulline Surprise	710v	17-50	22-23	1-27
Mystery	548v (437v)	137-00	141-35	1-03
New Find	409v	25-00	198-70	7-94
Nil Desperandum	434v (328)	646-75	889-76	1-37
Our Luck	311v	50-00	59-75	1-19
Queen Mary	583v	45-50	14-02	31
Refuse	423v	58-00	50-05	86
Reprieve Leases	422v, 462v	727-50	1718-25	2-36
Riverina Preseverance	545v	69-00	61-87	89
Rose and Shamrock	357v	121-00	66-85	55
Schnider	497v	18-00	14-15	78
Three Gins	705 (390)	12-50	33-78	2-70
Try Again	367v	200-75	195-17	97
Victoria	571v	62-00	97-14	1-56
Vera	385v	20-50	30-68	1-49
Waratah	661v	7-00	8-35	48
Yankee Doodle	708v (345v)	29-00	13-65	47
Young Australian	699v (332v)	170-00	373-17	2-19
Young Australian East	703v (332v)	7-50	3-04	40
Sundry Claims	...	570-00	840-92	1-47

Ularring District.

REDLEAP G.M.Ls. 89v, 92v (London and Coolgardie Explorers, Limited).—There are five shafts on this property sunk on a quartz reef running north-west and south-east. These shafts are all underlay, and are from 130 to 165 feet in depth; the most southerly is the deepest, and has been sunk on the underlay 165 feet to water. From this shaft levels have been put in at 100 and 130 feet, but very little work has been done at this latter level. At the 100 feet a drive has been put in along the reef 150 feet south and 50 feet north, and the reef stoped out to the surface for a length of about 150 feet. This shaft is at present abandoned. The north shaft has been sunk 135 feet, at which point water was struck; at 100 feet a drive has been put in along the reef for a total distance of 300 feet, and a block 100 feet in length has been stoped out up to the surface. The reef averages some 10 inches in width, but is very irregular. Its dip, which also varies considerably, is to the east. A large quartzite dyke runs alongside the reef for some distance, and cuts across it occasionally without, however, displacing it at all. Fresh water was met with in this mine, it being one of the few mines in the district from which the water is drinkable.

The total stone crushed from this property to the end of 1902 is 1191-15 tons for 2,751-78ozs., being at the rate of 2-31ozs. per ton, and worth £3 14s. 6d. per ounce.

Table showing Gold Returns from Leases at Ularring up to end of 1902.

Name of Lease.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Block 45	692v	6'00	2'45	'41
Central Off Chance	351v	11'00	1'76	'16
Cuba	348v	4'00	14'55	3'63
Derby	666v	101'25	193'28	1'91
Lady Emma	383v	10'50	11'00	1'04
Lady Betty	376v	10'00	4'90	'49
Matchless	346v	8'00	3'05	'38
Off Chance	338v	1224'50	2481'13	2'03
Puzzle	370v	37'00	28'78	'77
Shamrock North	371v	38'00	28'27	'74
Trio	360v	88'75	102'15	1'15
Yale Lock	406v	30'00	6'75	'22
Sundry Claims	...	6'00	2'70	'45

Mulwarrie District.

MOONSTONE G.M.L. 522v.—A small quartz reef runs almost due north and south through this lease; it has been worked at the north end of the lease by means of a number of shafts and short drives to a depth of about 70 feet. At this depth it is lost. The gold is found to occur in a series of short chutes which dip steeply to the north. The reef is from six inches to one foot in width, and runs vertically; it is crossed by several small granite and quartzite dykes, which run in a general north-west and south-east direction. Some of the stone obtained from these workings averaged as high as 10ozs.; they are at present abandoned, and prospecting is being carried on near the southern boundary of the lease in the hope of picking up another rich chute. The country is fine-grained greenstone, and becomes hard and settled at about 70 feet. Granite and quartzite dykes are numerous in the neighbourhood, and are mostly small. They generally run in a north-westerly to north-north-westerly direction.

Total crushings to end of 1902, 135'00 tons for 758'73ozs., an average of 5'62ozs. per ton, and worth £3 17s. 10d. per ounce.

MULWARRIE G.M.L. 9v.—Several shafts have been sunk on this property on a line of reef running about north-west and south-east. At present the reef is being worked from one of these, which is down to a depth of 320 feet (90 feet vertical, and the remainder underlay); from this shaft the lode has been stoped out for a length of about 120 feet from the 300 feet level to the surface. A main underlay shaft is at present being sunk on the reef about five chains farther south.

The lode averages from two feet to three feet in width, and dips at an angle of about 45 degrees to the north-east. It consists of a

quartz vein with a varying thickness of schistose formation accompanying it. The quartz vein varies in size from a few inches to as much as five feet or six feet in some places, in which case it practically fills the space between the walls, only a very little of the schistose formation being present. This, though it carries a little gold, is not as a rule sufficiently rich to pay for crushing. The quartz is found sometimes on the hanging-wall and sometimes on the foot-wall. The hanging-wall is very even and well defined, while the footwall is not so regular, pinches in the lode being due to rises in this wall. The country is fine-grained greenstone, very soft and decomposed in the upper levels, but becoming harder and more compact from about 90 feet. Numerous granite and quartzite dykes run across the lode, principally in a north and south direction. These are mostly small, ranging from a few inches to several feet in thickness. As a rule they do not throw the lode at all, but it is generally found to be poorer in close proximity to them. Water was struck at about 310 feet (measured on the underlay). It is slightly brackish, but drinkable.

Total crushings to end of 1902, 1,963·49 tons for 5,870·25ozs., being at the rate of 2·99ozs. per ton, and worth £3 11s. 8d. per ounce.

NORTH MULWARRIE G.M.L. 395U.—This property adjoins the Mulwarrie on the north, and the same line of lode has been worked on it to a depth of about 230 feet, measured on the underlay. Four underlay shafts have been sunk on the lode, the most southerly of which is only down about 70 feet, while the north or main shaft is down about 220 feet. About 50 feet of driving has been done from this south shaft, but it is not yet connected with the other workings. From the northern shaft about 400 feet of driving has been done at the lower levels, principally to the south, along the line of the lode. For the first 80 feet south from this shaft the lode consists of a talcose schist formation entirely free from quartz, and carrying only a slight trace of gold. South from this point the quartz begins to make and continues to the southern boundary of the property, averaging about two feet in width and dipping at an angle of about 45° to the east, and being similar in every way to the lode in the Mulwarrie lease. So far, no make of stone has been discovered to the north of the main shaft. As in the Mulwarrie, the lode is crossed by several granite dykes, which run between north-north-west and north-north-east, and vary in size from one to 10 feet.

Total stone crushed to end of 1902 is 1,168·00 tons for 1,977·35ozs., an average of 1·69ozs. per ton, and worth £3 17s. 10d. per ounce.

KILLALOE G.M.Ls. 401U, 506U.—A small north-west and south-east reef runs through about the centre of this property, and has been worked to a vertical depth of about 120 feet by means of several underlay shafts, sunk on the reef, the deepest of which is about 160 feet, measured on the underlay. From this level the

reef has been stoped out to the surface for a length of about 220 feet. It varies in size from almost nothing to about 15 inches, and dips to the east at an angle of about 45° . Associated with the quartz reef is from two to three feet of schistose formation, which usually carries a little gold, but not sufficient to pay for crushing. In the upper levels the quartz jumps from one wall to the other, but in the lower levels it keeps to the hanging wall, but is smaller and not so well defined as in the upper workings. The country is greenstone, soft and decomposed in the upper workings, but becoming very hard at the bottom levels.

Total crushings to end of 1902, 359.50 tons for 580.15ozs., an average of 1.61ozs. per ton, the gold being valued at £4 per ounce.

THUNDERBOLT G.M.L.—The owners of this property are working on a large felsite dyke which runs slightly west of north and east of south. On this dyke a shaft has been sunk vertically for about 45 feet, and levels driven north and south along the dyke for about 30 feet. A winze has also been sunk to a further depth of 15 feet. The dyke dips sharply to the eastward, and is from 20 to 30 feet wide. It carries a small amount of gold for its full width, as well as a considerable quantity of pyrites.

An irregular bunchy quartz vein runs along the hanging wall side of the dyke, and innumerable small quartz stringers run through it in all directions, forming a large stockwork. Some of the bunches of quartz are very rich, whilst others again carry only a trace of gold. Only these quartz bunches and the stockwork are being taken out at present. There have been no crushings to date, but the owners have about 80 tons of stone at grass, some samples of which, taken at random by myself and dollied, gave very good prospects.

About 12 feet north of the shaft the dyke is cut clean off by an east and west fault, and so far no attempts have been made to pick it up again in this direction.

ULARRING WESTRALIA G.M.L. 6U.—Two quartz reefs run through this property, both striking about north-west and dipping to the east at a steep angle. There are several shafts on each line of reef. The western reef is some four feet in width, but is very broken and irregular, especially in the upper levels. It has been worked out for a distance of 150 feet down to a depth of 75 feet. There are two short chutes of gold in this reef, one dipping north and the other south.

The eastern reef, which is the only one being worked at present, is smaller, being from 18 inches to two feet in width, but is much more regular, and has much better defined walls than the western, and gives every promise of continuing to live to a considerable depth. It can be traced on the surface for about ten chains through this property, and also for a considerable distance into the adjoining lease on the south. It has been worked out down to 65 feet for a length of about 120 feet, the chute of gold in this case dipping at a

rather steep angle to the south. The country is fine-grained greenstone, and gets very hard and compact at about 60 feet. There is a considerable quantity of pyrites in the quartz at the lower levels, carrying good values in gold.

This reef, like most of the others in this district, is intersected by several small granite dykes; these, however, do not affect the reef in any way.

Total crushings from this property to the end of 1902 are 497·25 tons for 971·60ozs., being at the rate of 1·95ozs. per ton.

MULWARRIE MAIN REEF G.M.L. 494u.—The main line of reef runs about north-west and south-east through the middle of this property. Five shafts have been sunk on this, two near the south end of the lease and three near the centre; of these latter the most northern is down 75 feet, the intermediate one 60 feet, while the third or main shaft is down 100 feet, 60 feet of which are vertical and 40 underlay. A winze has also been sunk a further distance of 20 feet from the bottom of this shaft. The lode has been worked out for 100 feet in length from the 70 feet level to the surface. A good deal of driving has also been done along the line of the lode at 100 feet, but no stopping. The lode, which dips to the eastward at a fairly steep angle, is from two to three feet wide, and consists principally of quartz, together with a little schistose formation on each side of the quartz. Occasionally the quartz pinches out to a few inches, its place being taken by the schistose formation, the walls still remaining the same distance apart. This formation is usually a good deal poorer in its gold contents than the quartz, but up to the present the greater part of it is being sent to the battery with the latter. The whole of the lode carries a considerable percentage of pyrites at the lower levels, a little galena being also present and being usually found only in the quartz. Small veins of calcite also run through both the lode and the country rock, which is a fine-grained greenstone, soft and decomposed to about 100 feet, but very hard and settled below this point. Water was struck at a depth of 115 feet (vertical) and is slightly salt.

A shaft has been sunk to a depth of about 50 feet on a small parallel quartz reef near the south-western corner of the lease, but no further work has been done upon it.

This property has crushed, to the end of 1902, 242·00 tons for 678·50ozs., being at the rate of 2·80ozs. per ton.

BUNINYONG G.M.L. 557u.—There are two parallel lines of lode running through this property in a north-west and south-easterly direction. The most western of these has been worked to a vertical depth of about 110 feet by means of several underlay shafts. This lode, which averages about two feet in width, and dips to the eastward at an angle of about 60°, consists of soft highly-decomposed chlorite schist, with which is associated a good deal of

quartz, usually occurring in bunches, some of them several feet in width, and generally very rich. A good deal of work has been done upon this lode, but it is at present (May, 1903) abandoned in favour of a small parallel lode some three chains farther east, on which a shaft has been sunk to a depth of about 25 feet, and about 20 feet of driving done. This lode is from six to twelve inches in width, and parts of it are very rich; it appears, however, to be cutting out at about the bottom of the shaft.

Total stone crushed to end of 1902 is 148·75 tons for 307·35ozs., including 11·00ozs., dollied and specimens, being at the rate of 2·06ozs. per ton.

TOLEDDA, G.M.L. 644v.—Near the north end of this lease two shafts have been sunk to cut a small quartz reef which runs slightly east of north and dips to the east at an angle of about 30°. The reef averages from eight to twelve inches in width, but is very irregular, some bunches of stone up to three feet in width being met with; these, however, are generally very short.

The reef is crossed by several north and south faults, which run practically vertically, and generally throw it from three to six feet. The country, which consists of fine-grained greenstone, is very soft and broken down to about 80 feet, at which point it begins to get more settled and harder. The reef has been stoped out from the 50 feet level to the surface for a length of about 100 feet. The main shaft has been sunk to a vertical depth of 85 feet, and about 50 feet of driving and a little stoping has been done at this level. A small amount of pyrites is present in the stone from these lower workings.

At the south end of the lease several shafts have been sunk on a quartz reef striking north-north-west and south-south-east, and dipping to the eastward. A good deal of work appears to have been done on this reef, but it is at present abandoned, and no particulars were available at the time of my visit.

Total crushings to end of 1902, 81·00 tons for 100ozs., giving an average of 1·23ozs. per ton, worth £3 8s. 9½d. per ounce.

OAKLEY G.M.L. 308v, 391v, 442v.—This property is situated about three and a half miles south-south-west from Mulwarrie townsite. A number of shafts have been sunk, and a considerable amount of work done on a small quartz reef striking about north-east and south-west, and dipping at an angle of about 45 degrees to the east. The reef is at present being worked only from the most northern of these shafts, the others being for the present abandoned. This shaft is down about 150 feet on the underlay. At the 125 feet level about 75 feet of driving has been done along the reef southerly, and the reef stoped out from this level to the surface for a length of about 50 feet; no driving has been done northerly. The reef is patchy, and varies in size from a few inches

to two feet—where seen it was from 10 to 12 inches—the walls, however, are clean and well defined. The country consists of fairly coarse-grained greenstone, and is very soft and decomposed down to the bottom workings, but not at all broken.

This property has, up to the end of 1902, crushed 1548·00 tons for 3430·46ozs., being at the rate of 2·21ozs. per ton.

Table showing Gold Returns from Leases in the Mulwarrie District, other than those already mentioned, up to the end of 1902.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Big Buck	363v	102·50	135·82*	1·32
Break o' Day	610v	57·00	13·00	·23
Cranbrook	581v (529v)	7·50	7·12	·95
Daimio No. 2	373v	24·00	63·93	2·66
Discovery	580v	136·00	63·05	·46
Droyfus' Release	430v	32·20	27·25	·84
Dum Dum	452v	10·00	8·37	·83
Enterprise	561v	109·00	68·20	·62
Fairy Queen	377v	108·00	47·71	·44
Federal	449v	12·00	7·35	·61
Floral	402v (50v)	72·00	49·19	·68
Golden Star	550v (449v)	10·00	9·75	·97
Killaloe North	658v	15·00	15·00	1·00
Lady Emma	383v	10·50	11·00	1·04
Mona	400v (40v)	164·50	318·74	1·94
Mt. Egan's Big Gun	252v	2·00	6·70	3·35
Mulwarrie West No. 1	554v	11·00	4·10	·37
Mulwarrie Perseverance	474v	9·00	9·30	1·03
Pride of the Hills	627v	111·00	368·20	3·23
Pride of Wales	657v	14·00	6·00	·43
Q.E.D.... ..	695v	8·00	12·60	1·57
Right Bower	419v	10·00	8·68	·86
Roseleaf	407v (366v)	74·50	128·86	1·72
South Mona	533v	41·00	122·35	2·98
Star	567v	19·50	25·65	1·31
Stella May	664v	9·00	5·45	·60
Stephenson's Big Gun	364v (252v)	74·00	72·32	·97
Sunnyside	607v	13·00	9·95	·76
Victorian	499v	33·00	12·70	·38
Welcome	520v (428v)	41·00	47·70	1·16
Sundry Claims	...	112·50	113·65	1·01

* Includes 3·82ozs. doliied and specimens.

Davyhurst District.

GOLDEN POLE G.M.Ls. 459v, 468v, 484v.—The main shaft on this property is down vertically to a depth of 300 feet, and levels have been put in north and south along the reef at 130, 200, and 300 feet. At the time of my visit the 300 feet level was full of water. At the 200 feet about 150 feet of driving has been done, principally south, and at the 130 feet about 400 feet, 250 feet south

and 150 feet north. No stoping has been done to date. Two old underlay shafts are also down on the reef, the deepest being 160 feet. The reef, which is of white quartz, has a general trend slightly west of north and east of south, and is about two feet in width on the surface, gradually widening to about four feet at the lower levels; it dips steeply to the east near the surface, but in the bottom workings is practically vertical.

At about 100 feet south from the main shaft the reef takes a sudden turn almost due east for about 60 feet, and then southerly again on its original course for another 150 feet, when it is cut off by an east and west fault, dipping steeply to the north. So far, no attempts have been made to pick it up again beyond this point. A considerable quantity of pyrites is present in the stone at the lower levels, and a good deal of manganese is associated with the quartz on the walls of the reef, especially in the upper levels. Water was struck at about 280 feet, and is salt. The country rock is a fine-grained greenstone, very hard and compact in the lower levels, but soft and decomposed down to about 130 feet.

Stone crushed to the end of 1902, 1,004·00 tons for 2,599·85ozs., an average of 2·58ozs. per ton.

HOMEWARD BOUND G.M.L. 441v.—Several lines of reef run through this property in a north-north-west and south-south-east direction. These reefs are bunchy, and in places run up to six feet in width; their dip is vertical. Very little work has been done on any of them, the deepest shaft being only down about 50 feet. The lodes consist almost entirely of quartz, with several inches of hornblende schist on the walls; this schist usually carries very good gold. The stone is very heavily mineralised after about 30 feet from the surface. The country is very hard, compact greenstone, the zone of weathering only extending down about 30 feet.

Total crushings to the end of 1902, 151·00 tons for 102·15ozs.

HOMEWARD G.M.L. 440v.—The main shaft on this lease is down 95 feet vertically. A crosscut has been put in westerly at this level for a distance of 40 feet, when the reef was cut. This reef has been driven on for from 15 to 20 feet northerly; it consists of a quartz vein some 18 inches in width, with several inches of schistose formation on the walls, and dips at an angle of about 75° to the west.

A second shaft has been sunk on a second line of reef farther east to a depth of 100 feet, and the reef stoped out for a length of 75 feet from the 100 feet to the 50 feet level. Above this level the stone is of too low grade to pay to take out.

This property has, up to the end of 1902, crushed 157·00 tons for 288·80ozs., an average of 1·84ozs. per ton.

WAIHI G.M.L. 438v.—Three parallel lines of lode run through this lease in the prevailing north-west and south-east

direction. On the most westerly of these a main shaft has been sunk to a vertical depth of 285 feet. Levels have been put in at 275, 200, 100 and 50 feet, and a good deal of stoping done at the two upper levels. This western ore body is some 100 feet in length, and is from two to four feet in width. It consists principally of quartz with varying thicknesses of schistose formation on the walls. At the lower levels very little quartz is present, and the formation carries only a very small amount of gold. In the upper levels the stone was very good, and some rich parcels were taken out.

Water was struck in the main shaft at 280 feet, and is salt. On a second lode, a couple of chains farther east, a shaft has been sunk to a depth of 100 feet, and a winze put down a further distance of 30 feet. A little driving has been done at the 100 and 50 feet levels, and a little stoping has also been done at the latter level. The lode, as opened up in the lower levels, consists of a rather irregular quartz reef some four feet in width, running vertically. Near the surface it is only about two feet. The country here gets very hard after about 50 feet. A small quartz reef, which appears to be a continuation of this one, has been worked at the extreme north end of the lease to a depth of 60 feet; not very much work has been done on it, however. A shaft has also been sunk to about 80 feet on a third line of reef still farther east, but no work beyond this has been done on it.

Total stone crushed up to the end of 1902 was 1,015·50 tons for 2,171·47ozs., including 5ozs. dollied and specimens, being at the rate of 2·13ozs. per ton.

EILEEN G.M.L. 458U.—The owners of this property are working on a large irregular lode, running about north-north-west and south-south-east, and dipping at about 60° to the west. The lode consists of a body of soft, highly decomposed chlorite schist, some six to eight feet in width, throughout which is disseminated a considerable quantity of quartz, both in the form of bunches and small veins running through the lode. It has no defined walls, and varies a good deal in size, being in one place as much as 20 feet in width. An underlay shaft has been sunk to a depth of 130 feet on the lode, which is here about six feet in width, and a drive put in along it at the 105 feet level for a distance of about 150 feet, and the lode stoped out for about 50 feet up from this level. The chute of gold at present being worked is about 150 feet in length, and dips to the north at a fairly flat angle. A main vertical shaft is being sunk a few chains to the north-west of the present workings. This is now (June, 1903) down about 200 feet. Salt water was struck in it at about 170 feet, at which point the country begins to get hard, being very soft and decomposed down to this point.

This property, up to the end of 1902, has crushed 1,867·00 tons for 2,435·12ozs., being at the rate of 1·30ozs. per ton, the gold being valued at £4 0s. 6d. per oz.

OASIS R.C. 92v.—The lode in this lease runs almost north and south, and dips to the westward at an angle of about 45° . It is very similar to that in the Eileen, consisting of a belt of highly decomposed schist averaging some four feet in width. It is very irregular, being as much as 10 feet in width in some places, and has no defined walls. A good deal of quartz is associated with it, occurring in bunches and small veins throughout the lode. The chute of gold being worked at present dips at a flat angle to the north. The lode is at present being worked from a shaft sunk to a depth of 65 feet near the south end of the lease. Two sets of levels have been put in from this shaft, one at 30 feet for a distance of 50 feet north, and one at 65 feet for 100 feet. Very little stoping has been done from either of these levels. There are also several other shafts farther north on the lode, the deepest of which is down vertically 165 feet. These are at present abandoned, but a good deal of work appears to have been done from them. Water was struck at 165 feet, and is salt. The country, as far as opened up, is very soft decomposed greenstone. Several other small shows are also working on this same line of lode farther to the south.

GREAT OPHIE, G.M.L. 618v.—This property is situated about a mile and a-half to the north-east of Davyhurst township. There are four shafts on it, the deepest being about 90 feet. Of these shafts, one is vertical and two are partly vertical and partly underlay, while the fourth is a new shaft somewhat to the west of the others, which the owners intend sinking to a depth of 200 feet in order to try and obtain a supply of water. The country, as far as tested, is very soft, and consists of highly decomposed greenstone. There are several parallel lines of lode running across the lease in a general west-south-west and east-north-east direction. These vary in size from a few inches to about four feet, and consist of bands of highly foliated greenstone—probably old faults or joint planes—much decomposed, and carrying a considerable amount of oxide of iron, and throughout which a fair quantity of quartz is disseminated. The gold is found, for the most part, as very thin scales on the faces of the cleavage planes of the schists, and is extremely light and difficult to save on the battery plates. The main line of lode at present being worked averages about four feet in width, and dips at a flat angle to the north. Only a small amount of driving and stoping has been done on it. In the main vertical shaft a large body of brecciated quartz was met with at about 80 feet. At the time of my visit it was impossible, owing to no work having been done upon it, to say what the size of it was, or in what direction it was running; it may, however, be the continuation of a small north and south quartz reef which outcrops on the south end of the property, and on which a little work has been done to a depth of about 20 feet. This reef is here about 12 inches in width, and runs on a bearing of 340° ; its dip is vertical, the stone is bluish quartz, and shows coarse gold freely.

Crushings to end of 1902, 99'00 tons for 72'30ozs., being at the rate of '73oz. per ton.

Table showing Gold Returns from Leases in the Davyhurst District, other than those already mentioned, up to the end of 1902.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Champion	485u	36·00	17·30	·48
Forget-me-not	480u	176·00	440·24	2·50
Glengarry	465u	14·00	14·65	1·05
Golden Lode	691u	87·00	83·90	·96
Hanover	564u	47·00	40·40	·86
Hypatia	563u	50·00	23·20	·46
Jubilee	680u (620u)	39·00	33·00	·84
Lady Kate	697u (455u)	23·00	32·05	1·39
Macedon	659u	24·00	16·35	·68
Melrose	686u (439u)	35·00	95·35	2·72
Metalline	604u	54·00	39·50	·73
Three Hills	572u	40·00	2·20	·05
Waihi Consols	496u	73·00	168·30	2·30
Waihi North Extended	479u	11·00	44·75	4·06
Warne's United	491u	3·30ozs. dollied and specimens		
Sundry Claims	...	305·05	263·07*	·86

* Includes 1·40ozs. dollied and specimens.

SUMMARY.

In conclusion, it will be seen from the following table that the average gold yield from the district per ton of ore treated is an exceptionally high one, and also, as the ore value diagram shows, the total gold production for the whole Ularring district has been steadily increasing every year. There is no reason why, with systematic mining, together with the erection of suitable machinery, this increase should not be multiplied many times during the next few years.

Synoptical Table showing total Gold Yield from the District comprised within the boundaries of the map, up to the end of 1902.

	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Mulline	26,198·22	36,439·88	1·38
Ularring	2,766·15	5,632·55	2·04
Mulwarrie	7,501·69	16,464·08	2·18
Davyhurst	5,307·55	8,986·25	1·69
District generally—			
Being sundry parcels treated at Mulline and Mulwarrie State Batteries	47·00	2,027·90	...
Returns from voided leases	2,968·30	4,074·67	1·37
Total	44,788·91	73,625·33	1·64

CHAS. G. GIBSON,
Assistant Geologist.

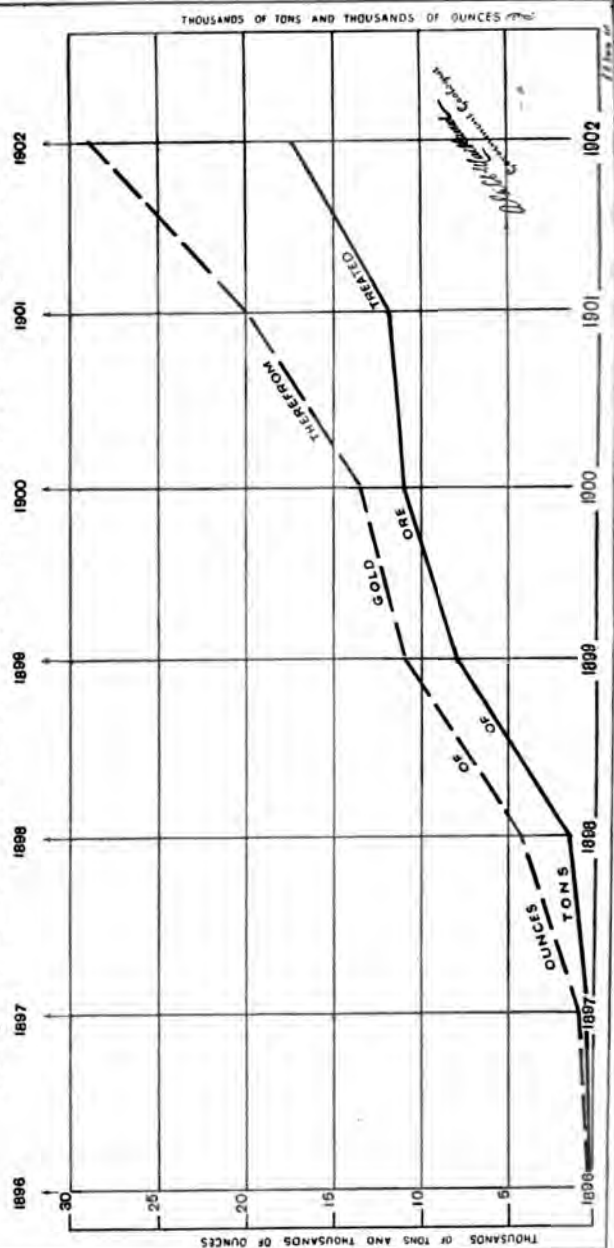
APPENDIX I.

List of Specimens obtained from the Ularring District.

Number of Specimen.	Registered No. of Microscope Section.	Name of Specimen.	Locality.
308	337	Felsite (dyke rock)	20 chains west of G.M.L. 3632, Ularring
309	...	Felsite (dyke rock)	2 chains south from above
310	338	Diorite	G.M.L. 3632, Ularring
311	339	Diorite	30 chains S.S.E. of G.M.L. 358, Ularring
312	340	Granite (dyke rock)	G.M.L. 311, Ularring
313	...	Laterite	G.M.L. 309, Ularring
314	341	Biotite granite ...	Ularring Rocks, Ularring
315	342	Felsite (dyke rock)	Thunderbolt G.M., Mulwarrie
316	...	Granite (dyke rock)	G.M.L. 506, Mulwarrie
317	...	Gold in schist ...	Great Ophir G.M., Davyhurst
318	...	Copper Ore	G.M.L. 4550, Ularring

APPENDIX II ULARRING DISTRICT ORE VALUE DIAGRAM

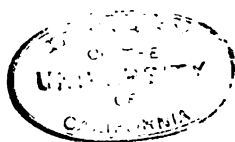
Shewing No of Tons of Ore treated and No of Ounces of Gold obtained therefrom for each year since 1896



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1904.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 13.

GEOLOGY AND AURIFEROUS DEPOSITS

OF

LEONORA,

Mount Margaret Goldfield,

BY

C. F. V. JACKSON,

ASSISTANT GOVERNMENT GEOLOGIST.

*Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.*

WITH MAP AND SHEET OF SECTIONS.



PERTH:

BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.

1904.

GEOLOGICAL MAPS AND REPORTS ISSUED BY THE GEOLOGICAL SURVEY OF WESTERN AUSTRALIA.

I.—MAPS.

- Geological Map of Northampton: by A. Gibb Maitland. Scale, 20 chains per inch. Price, 2s. 6d. 1898.
- Geological Map of the Collie Coalfield: by A. Gibb Maitland. Scale, 40 chains per inch. Price, 2s. 6d. 1898.
- Geological Map of Coolgardie: by Messrs. T. Blatchford and E. L. Allhuesen. Scale, 10 chains per inch. Price, 10s. 1898.
- Topographical Map of Menzies: by W. D. Campbell. Scale, 20 chains per inch. Two sheets. Price, 2s. 1899.
- Geological Sketch Map of the country between Cue, Peak Hill, and Menzies, from the latest official information. Price, 1s. 1900.
- Topographical Map of Kalgoorlie: by W. D. Campbell and S. J. Becher. Scale, 10 chains per inch. Four Sheets. Price 5s. 1900.
- Mining Map of the Boulder Belt: by W. D. Campbell. Scale, 4 chains per inch. Two sheets. Price 5s. 1900.
- Geological Map of the North Lead, Kanowna: by Torrington Blatchford. Scale, 8 chains per inch. Price, 1s. 1901.
- Geological Map of Kalgoorlie: by A. Gibb Maitland and W. D. Campbell. Scale, 10 chains per inch. Six sheets. Price, 21s. 1902.
- Geological Map of Lennonville: by A. Gibb Maitland and C. G. Gibson. Scale, 15 chains per inch. Price, 1s. 1902.
- Geological Map of the Boulder Belt and Sheet of Horizontal Sections: by A. Gibb Maitland and W. D. Campbell. Scale, 4 chains per inch. Three sheets. Price, 12s. 6d. 1903.

II.—REPORTS.

Reports by the Government Geologist in connection with the Water Supply of the Goldfields (price, 2s. 6d.), containing—

- (a.) Proposed Boring for Artesian Water on the Coolgardie and Kalgoorlie Goldfields.
- (b.) Possibility of obtaining a Supply of Artesian Water at Menzies.
- (c.) Cue Water Supply for Crushing Purposes. 1897.

Annual Reports. Price, 2s. 6d. each:—

1. Progress Report for the Year 1897, containing—

Ferruginous Conglomerate at Coates Siding; Geological Features and Mineral Resources of Northampton; Country between Northampton and Peak Hill; Geology of the Peak Hill Goldfield; Horseshoe Diggings; Artesian Water; Fumes from Fremantle Smelting Works; Native Tellurides of Gold; Mineralogical and Petrological Notes; So-called Deep Lead at Kanowna; The 25-Mile Cement Leases; Coolgardie Goldfield. (*Out of print.*) 1898.

CORRIGENDA.

Inside Cover Page, line 20:

for "a Gibb Maitland," read "A. Gibb Maitland."

Page 4, line 2:

for "face page 4," read "face page 1."

Page 4, line 11:

for "face page 26," read "face page 25."

Page 4, line 12:

for "face page 24," read "face page 28."

Page 4, line 23:

for "face page 28," read "face page 30."

Page 10, line 29:

for "South-Eastern corner," read "South-Western corner."

Page 25, line 21:

for (;) after Granite, read (.)

Page 25, line 21:

*for "While in the vicinity of the workings in the Greenstone,"
read "In the vicinity of the workings it is in the Greenstone."*

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PREFATORY NOTE.

 HIS report on the Geology and Auriferous Deposits of Leonora is one of a series designed to treat of the different important mining centres of the State. No previous detailed report has been issued on the district, although reference has been made to it by Sir John Forrest in 1869, and Mr. S. Göczel in 1894. The present report is the first which contains a geological map and sections of Leonora. The field work, upon which Mr. Jackson's work is based, was commenced on the 7th of July, and concluded on the 10th of October. The area embraced by the work extending over about 70 square miles.

The rocks of the district comprise a complex of crystalline schists which form the continuation of that group which is so largely developed in the other portions of the Eastern Goldfields, and are no doubt of the same geological age, viz., Archæan. Detailed mapping, however, has been rendered difficult by the cover of superficial deposits which occupy such an extensive area, and effectually conceals important geological boundaries often in critical localities.

According to Mr. Jackson's observations, it appears that the crystalline schists comprise both basic and acidic rocks. The basic rocks, which comprise the main auriferous series, form a belt of about an average width of one mile, and a proved length of 10 miles. This belt, however, extends much further to the North and South than the area embraced by Mr. Jackson's work. Some of the basic rocks (greenstones) have been converted into schists which are largely developed along the outer margin of the main belt, whilst the centre portion is occupied by more or less massive rocks. There seems good reason to believe that the foliated and schistose rocks are merely portions of one and the same mass which have suffered more or less dynamical metamorphism, possibly modified by chemical action.

All the important ore deposits are confined to the greenstones and their derivatives, which have yielded fully 95 per cent. of the total output, and on that account are worthy of careful investigation.

The greenstones have been invaded by granitic rocks, which latter occupy by far the most extensive area of country examined. The acidic rocks are both massive and foliated; it has, however, not been found possible to, in all cases, separate the different varieties. It is, however, quite possible that more detailed examination than was deemed expedient would result in the recognition of two distinct series of granitic rocks, (a) an older, traversed by zones of secondary shearing, possibly associated with auriferous quartz reefs, and (b) a much newer and comparatively unmodified granite, which may be represented by the felsite dykes, which traverse the greenstone schists in the north-west corner of the area in the vicinity of the Leonora Gold Blocks.

The exigencies of field work prevented detailed petrographical work being carried out, but a series of rocks have been sliced, and as opportunity offers they will be microscopically examined.

The granites and greenstones are covered in places with lateritic deposits, a high and a low level laterite having been recognised, but it has not been found possible to separate both on the map, hence the two varieties have been distinguished by the same colour and symbol.

The ore deposits have been conveniently divided into four classes, particulars of which are fully set forth in the text.

The report is accompanied by schedules of gold returns prepared from the latest official statistics; these demonstrate that from the area embraced by Mr. Jackson's work there have been raised, up to the end of 1903, 331,824·92ozs. of gold, the result of the treatment of 420,792·50 tons of quartz, being at an average rate of 0·78ozs. per ton.

The report, map, and sections, having been submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

The index to names, places, mines, reefs, etc., occurring in the report, has been prepared by Mr. H. W. B. Talbot, the Field Assistant.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Perth, 4th February, 1904.

GEOLOGY AND AURIFEROUS DEPOSITS

OF

L E O N O R A

(Mt. Margaret Goldfield).

INTRODUCTION.

History of the Mount Margaret Goldfield.

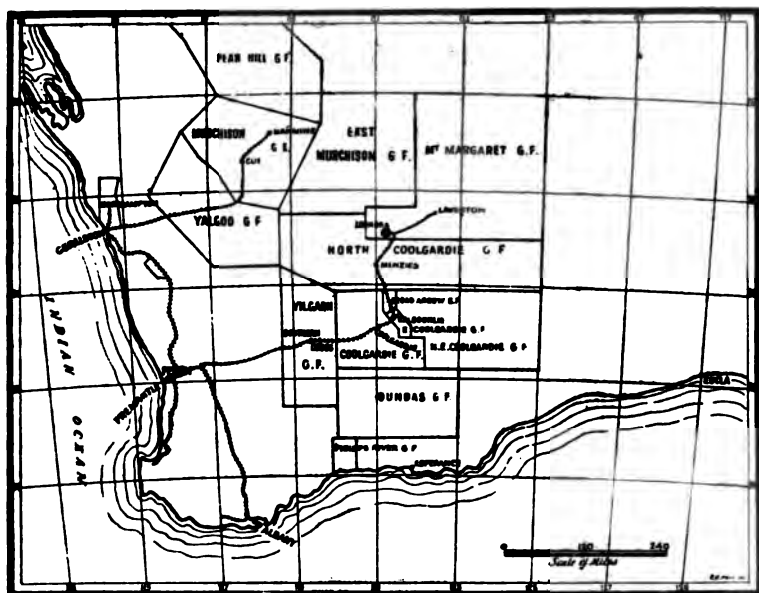


FIG. 1.--LOCALITY MAP.

PRODUCTION.

The following is a tabulated statement of the gold production of the total ore of the Mt. Margaret Goldfield, as defined by the authorities:—

		oz.		£
Previous to 1897	...	4,992·10	...	18,471*
1897	...	22,592·09	...	83,591
1898	...	49,717·77	...	183,956
1899	...	79,923·72	...	295,718
1900	...	145,688·75	...	539,048
1901	...	190,032·15	...	703,119
1902	...	211,308·77	...	781,842
1903	...	212,490·60	...	786,215
Total ...	...	<u>916,745·95</u>	...	<u>£3,391,960</u>

* Value of gold, assumed, £3·70 per oz.

The route followed by Sir John Forrest, when commanding the West Australian Expedition in search of the remains of Dr. Leichardt and party, crossed the now existing boundary of the Mt. Margaret Goldfield, near the South-Western corner, and the history of the country comprising its area commences, geographically speaking, with following extract from the explorer's diary of the expedition :—

24th June, 1869. "From the summit of a remarkable peak, which I named Mt. Flora, I obtained a round of bearings, and saw a high range bearing about north 106° east mag., apparently about 16 miles distant, towards which we travelled till after dark.

"25th. Saddled at dawn and proceeded to the range, about five miles distant, and on reaching it I ascended the highest peak, and named it Mt. Margaret."

From that date but little further knowledge was gained of the country, or, indeed, little attention paid to it, for more than 20 years; and it was not until 1894 that the Mt. Margaret, or Lake Carey, country began to be regarded as a prosperous and rising district.

In a report on the Interior Gold Region of Western Australia, (*) published in 1894, Mr. S. Göczel, describing the country passed over on an expedition from the "Ninety Mile" to Lake Carey, mentions the Lake Raeside depression, which he crossed some miles to the south of Mt. Leonora, and which forms the drainage area of the southern portion of the field. He noted the position of the large outcrops of granitic rocks, which rise as a range of bare hills to a height of 200 feet above the surrounding country, and form, with a width of about five miles, the divide of the watershed of Lakes Raeside and Carey. Mr. Göczel further stated that a long stretch of country, situated at the junction of this gneissic granite on the west, and greenstone on the east, had already been proved auriferous, and he mentioned the "Red Castle" line of reef and the "Goose's Puzzle," and stated that, though rich finds had not been made up to that time, a number of reefs offered chances for profitable mining enterprise.

Farther east, on the range of which Mt. Margaret forms the highest point, he referred to alluvial gold deposits at Red Flag, Hawk's Nest, and other surface workings, the Hawk's Nest being the richest.

At the end of 1895 the population of the whole of this large district amounted to 730, while there were 3,400 acres held under mineral lease, and two 10-stamp batteries situated at Mt. Margaret.

During 1896 numerous new finds were reported, viz., Mt. Margaret, Mt. Malcolm, Mt. Leonora, and Murrin Murrin, all then within the North Coolgardie Goldfield; and it was not until the 1st April, 1897, that Mt. Margaret was constituted an independent goldfield, formed by separating portions of the North Coolgardie and East Murchison Goldfield, and having an area of 42,154 square miles.

* Report on the Mines Department. Perth: By Authority, 1895.

Apparently, at the time, the centre of Mt. Malcolm gave promise of being the most important, and the Warden's Office for the transaction of the departmental business of the new field was opened there on the 10th May, 1897, the area being divided into the two districts of Mt. Margaret, 17,150 square miles on the eastern side, and Mt. Malcolm, 2,516 square miles on the western side.

In the same year the Westralia Mt. Morgans Gold Mines was registered as a local company, and on the 3rd March following the Sons of Gwalia, Limited, which gave a great impetus to the mining centres of Leonora and Morgans, these two mines being now the chief producers of the field. The Under Secretary for Mines, in his Annual Report for 1898, refers to the developments of the field during that period as being little short of phenomenal.

During 1899 a public battery started operations at Leonora, and further copper deposits were found and furnaces erected at Anaconda, in the vicinity of Murrin, where similar ores had been previously located. The yield of gold for the year amounted to 5 per cent. of the total production of the State. Developments were almost equally satisfactory in the following year, 1900, especially in the vicinity of Mount Margaret, and to the east and south-east of Laverton; and 4,539 tons of copper ore were treated at Anaconda. The gold yield rose from 5 per cent. to 9·6 per cent. of the State's total production, a proportion which increased to 10·3 in 1901, when the copper output from Murrin, valued at £40,738, amounted to rather more than half the State's total. The Warden of the field reported, at the end of 1901, that progress was marked more by attention to legitimate development of prospecting shows and mining at a depth than by the opening up of new country; remarks which apply also to the following year, when, however, the yield of copper showed a falling off, and the output was only valued at £6,852.

The gold production, nevertheless, maintained a satisfactory increase, and in April, 1902, a slight alteration was made in the administration of the field, by the creation of the new district of Morgans; the centres being now Malcolm, Morgans, and Laverton, the relative importance of which, as producers, is shown by the following comparative statement:—

1902.		
District.	Population.	Production.
Malcolm (including Leonora) ...	2,170	oz. 88,842·92
Morgans	1,114	59,091·55
Laverton	2,741	63,374·30

It appears, therefore, that since 1896 the record of the field has been one of continuous prosperity. A number of townships have grown up round the more important mines, and while the population of the field has increased from 730 to 6,025, the annual gold production in the same period has risen in value from £83,591 in 1897, to £781,842 in 1902.

It is not inappropriate to add that, speaking generally of the country passed over on his expedition in 1869, Sir John Forrest remarked: "As for minerals, I am not sufficiently conversant with the science to offer an opinion, except that *I should think it worth while sending geologists to examine it thoroughly.*"

LEONORA DISTRICT.

HISTORY.

The following table shows the total gold production of the Leonora District:—

PRODUCTION.

	Ozs.	£
Previous to 1897 ...	112·10 ...	415*
1897 ...	9,050·91 ...	33,511
1898 ...	19,475·37 ...	72,059
†1899 ...	27,673·87 ...	102,393
‡1900 ...	60,084·61 ...	222,313
1901 ...	72,008·18 ...	266,430
§1902 ...	68,804·58 ...	254,577
1903 ...	74,609·30 ...	276,054
Total ...	<u>331,824·92</u> ...	<u>£1,227,758</u>

The township of Leonora is the present terminus of the Eastern Goldfields Railway, situated 323 miles to the east and 225 miles to the north of Perth.

The Leonora district forms portion of and occupies the south-eastern corner of the Mt. Margaret Goldfield, and its early history therefore also begins with the West Australian Exploring Expedition in 1869; not merely in a general sense, however, but, as

* Value of gold, assumed, £3·70 per oz.
 † Sixty stamps working at Sons of Gwalia.
 ‡ Sixty stamps working at Sons of Gwalia.
 § Sons of Gwalia output diminished. Mining costs decreased, profits increased.

† Ten stamps working at Sons of Gwalia.
 § Sons of Gwalia output diminished. Mining costs decreased, profits increased.

is worthy of note, the country was traversed and examined in some detail. Quoting the paragraph from Sir John Forrest's memoirs especially referring to the locality:—

20th June, 1869. "From a bare granite hill about one mile from camp, I saw a high hill bearing north $81^{\circ} 30'$ east mag. about 25 miles distant, which I named Mt. Leonora; and another bearing north 67° east mag. about 25 miles distant, which I named Mt. George. Intend proceeding to Mt. Leonora to-morrow."

21st June. "Steering towards Mt. Leonora, over some tolerably grassy country, we reached it at sundown, and not finding any water, camped without it, with very good feed; in south latitude $28^{\circ} 53'$ by meridian altitude of Lyræ (Vega) and Aquilæ (Altair), and in longitude about $121^{\circ} 20'$ east."

Thus is recorded the earliest history of the laudmark from which the district derives its name.

In tracing its mineral history, it seems probable from what has already been said with regard to the Mt. Margaret goldfield generally, that the deposits mentioned by Mr. Göczel in 1894 include all those which were first known within its boundaries, and it is unlikely that there was then any mining in the district; though alluvial gold appears to have been discovered by fossickers not long afterwards.

It is generally agreed that the first discovery of an auriferous formation which led to more extensive search, and ultimately brought to light the valuable deposits now being worked, was made in 1896, by two prospectors—Sullivan and Weddeck—who, like most pioneers, arrived on camels, probably from Menzies or Niagara, the then nearest centres.

They discovered gold showing in a quartz outcrop about one and a-half miles north-north-west of the present township. Their lease, No. 4048, now the site of the public crushing battery, and known as the Johannesburg, was applied for on the 11th March, 1896, and surveyed on the 18th November of the same year. It has been forfeited and held again at different dates and under different numbers, i.e., 238r, 152c; but, except that a good deal of rich gold was obtained from a large boulder forming part of the outcrop, there is but little authentic information concerning it. After the rich surface stone was worked, however, and a shaft put down, the ore proved too low grade or the vein too small to be payable. Occasionally fossickers are said to have obtained small parcels, the returns of which are no doubt included in the statistics under the head of "Sundry Claims," with the exception of a single crushing in 1902 of eight tons, which yielded 50zs. of gold.

The two original prospectors were followed closely by others, and the next find of importance was made by McPhie and party, who discovered a reef two miles farther north, and pegged out Lease No. 195c, known as the "Great Wonder," now the "Leonora

Gold Blocks." The application for this lease was made on the 3rd June, 1896, while that for Lease No. 4263, containing the outcrop of the Sons of Gwalia lode, appears in the official register dated the 2nd June, 1896, though which of the two takes precedence as regards the discovery of the deposit is not recorded therein.

A great number of leases were quickly taken up surrounding those held by the lucky prospectors, and, as shown by departmental records, the progress of the district as a mining centre has been extremely rapid: a result, however, in great part due to the richness of the Sons of Gwalia lode, and intimately connected with the development of that property on a large scale after its purchase from the prospectors by Mr. G. W. Hall in 1896 for the sum of £5,000.

From 77 per cent. of the total in 1897, the production of this mine had risen at the end of 1902 to 93 per cent.; and the total output of the field for the same years amounted to 9,057·17ozs. in 1897, and 68,804·58ozs. in 1902. The increment added by the public battery, which started operations in 1897, and has crushed to date 10,960·5 tons for a yield of 10,153·82ozs., amounts in value to £38,583·18.

The accompanying geological map comprises an area of 70 square miles, hereinafter referred to as "the district."

It is bounded by an east and west line at Mount George, $4\frac{1}{2}$ miles to the north of Leonora, and by a similar parallel at Lake Raeside, 5 miles to the south. On the east and west by meridian lines 4 miles and $3\frac{1}{2}$ miles from the township respectively.

PHYSIOGRAPHY.

Approaching Leonora from the south, the general appearance is that of a long ridge of more or less pointed hills, extending with a north-westerly axis to Mount George; and in a southerly direction beyond Mount Leonora to Lake Raeside. The altitude of Mount Leonora and Mount George, which form the most prominent features, being 250 feet and 225 feet respectively above the surrounding plains.

This ridge, running diagonally from north-west to south-east, forms a natural division of the district into two parts, which it has been found convenient to refer to in the following pages as the eastern and western side of the area.

On the west are wide flats extending with an imperceptible slope to the eastern side of the Lake Raeside saltmarsh, which stretches in a north-westerly and south-easterly direction for at least 100 miles, and of which the deepest parts are occupied by salt-water pools, and then dried up beds.

The country to the east, though largely occupied by flats, is rather more broken.

The district forms portion of the eastern watershed of Lake Raeside, the divide between this and the Lake Carey drainage area being approximately 12 miles to the east, while in a westerly direction, at a distance of from 4 to 5 miles, the country begins to fall towards the Lake Barlee Basin.

Mr. Güczel, in 1894,* writing of the Interior Goldfields of Western Australia, refers to them in general terms as being situated in a region having very slight, if any, drainage towards the sea: "Absorption, evaporation, and percolation to the saline flats and salt lakes balancing the rainfall." The altitude of Leonora, but slightly different from the other goldfields, is about 1,220 feet above sea level; and the annual rainfall of the district, so far as records have been kept, has varied from a minimum of three inches in 1897 to a maximum of 12·16 inches in 1900, or an average for the six years of 7·42 inches.

Relatively speaking, the district is well provided with water, that first met with in the mine and well shafts being freely made use of. This supply is generally obtained at about 60 feet, but at a shallower depth in the alluvium to the west, where several areas have been selected for cultivation. The water obtained from the upper levels, though containing a fair proportion of lime and magnesia salts, is used for boilers; and, suffice it to say, with certainly not more than the average inconvenience attendant on the use of such water on the goldfields, where the necessary boiler-cleaning resulting on the presence of a considerable proportion of solids has frequently to be undertaken.

Tanks are chiefly relied on for drinking water, but the township is provided with a gravitation supply, the water being obtained from a well and raised to an elevated reservoir by a powerful windmill pump.

GEOLOGY.

Broadly speaking, the district may be geologically defined as an area of crystalline schists; of which by far the greater portion is covered by recent superficial and alluvial deposits. These latter are in most cases derived from the accumulated detritus of the older rocks, while metamorphism has not in general been so great that the nature of the rocks themselves cannot be distinguished; and according to the acid or basic character of the original form, a geological division made conformable with the general scheme of rock classification.

In point of geological age, also, the rocks can generally be recognised as referable to, in fact, part of the same group so largely developed in the Eastern districts, and outcropping, as they do, at either one or another of the mining centres thus situated.

* *Ad Interim Report on the Department of Mines, 1894, pp. 24, 25.*
Perth: By Authority, 1894.

Geologists, writing of the Goldfields,* have described them as being divisible into three sections—Granites, Gneisses, and Schists; and on this basis have assigned a more or less definite position to each, thus:—

“The first auriferous belt of hornblende, mica, or talc schists (about 20 miles in width) extends from the Southern Cross Goldfields in a south-easterly direction to the south coast, and in a north-westerly direction to and beyond Cue, in the Murchison Goldfield.

“The second auriferous belt, similarly composed, includes Coolgardie, Kalgoorlie, and extends with a parallel axis, and with a width not yet explored, from Norseman on the south, through the Pilbarra Goldfield, to Egina and Mallina on the north-west coast.

“The Leonora District, in fact the whole of the Mt. Margaret Goldfield, is included within the second auriferous belt; the country between the belts and to the west being occupied by the above-mentioned granites.”

At the same time the granites, gneisses, and schistose derivatives were classed as Archæan rocks, and have been most frequently thus spoken of by other geological observers; while the diorite, diabase, pyroxenite, with the hornblende and chlorite schists, have been most generally referred to as “paleozoic greenstone.”

Both granite and greenstones are represented at Leonora, and an examination of the small area, though not affording any new evidence as to the exact geological age of the formation, raises the question of the ages of the rocks within it, in so far as the relation is concerned, of the greenstones to the granites, to which discussion in this respect is practically limited, for though each division undoubtedly contains more than one primary form, further separation is impossible owing to so large a proportion of the area being completely hidden from view, as well as to the highly decomposed state of the schists where outcrops can be examined.

The crushed rock forming Mount Leonora, as well as the smaller areas to the north and south, is no doubt of intrusive origin and of later age than the greenstones, as also probably the remainder of the granite area represented; but further evidence in support of the latter general conclusion would be more satisfactory.

SUPERFICIAL ACCUMULATIONS.

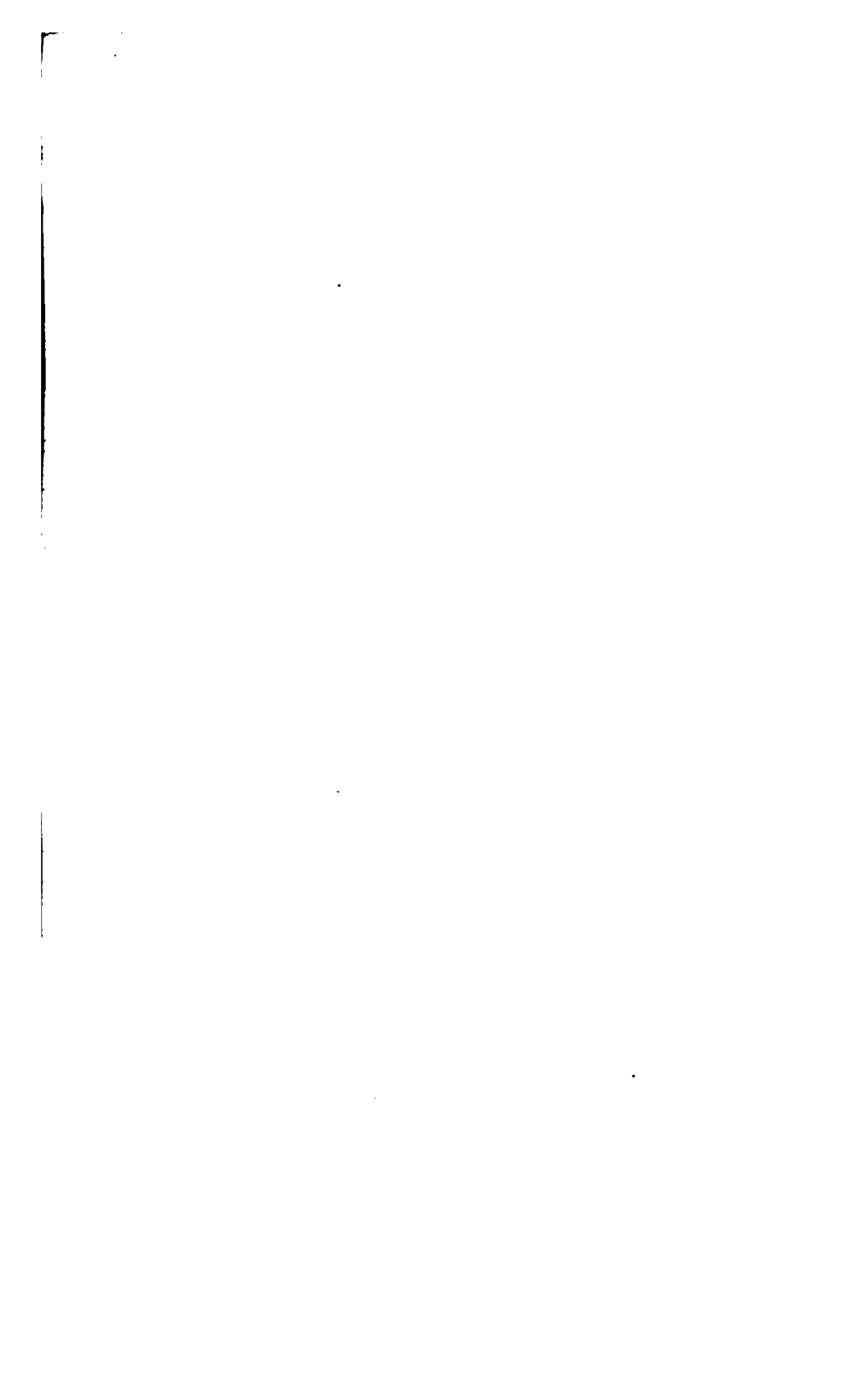
The development of recent accumulations in the district is very extensive, as indeed has already been noted on almost all our Eastern Goldfields; but there are many important features with regard to these residual deposits and their distribution at Leonora, where in one form or another they cover all except the most elevated areas.

On the eastern side, occupied by the granitic schists, the surface is covered by the usual soil resulting from the decomposition

* Mining Handbook to the Colony of W.A. Harry P. Woodward, pp. 36, 37.
Perth: By Authority, 1896.



High-Level Laterite, One Mile North-East of Mount George.



of the schists *in situ*, which, in the depressions, has accumulated to a very considerable deposit forming wide sandy flats. The higher portions, however, from which the finer products of degradation have been removed, are more frequently covered by quantities of ironstone, consisting of fragments of highly ferruginous clay, representing those portions which have become hardened, and charged, no doubt by a concretionary process, with the iron of the original rock mass, now become to a great extent bleached and decomposed.

On the western side the superficial covering is probably in great part more of an alluvial character, no doubt of considerably greater thickness; and to it, even now, are being added the more or less sedimentary accumulations of Lake Raeside. The waters of this lake, in addition to the deposition of mechanically suspended silt, have left in places, chiefly as a result of evaporation, a siliceous residue of lime salts, particularly at the outer margins. In some cases the lime is sufficiently free from other substances to form, when burnt, a local supply for building purposes, but as a rule is too impure.

Apart from the influence which the existence of the salt pools or lake may have had upon its present form, practically the whole of the material filling the depression on the western side appears to have been derived from the disintegration, *in situ*, of a previously existing residuary deposit, *i.e.*, the ironstone gravel, which bears a comparable resemblance to the laterite of such wide distribution throughout India and Ceylon.

This formation, the remains of which are shown on the map, either in the high level or low level form, no doubt not only covered the greater part of this area, but extended through the gap in the dividing ridge known as the "Gorge" for a considerable distance beyond the limits of the map. These laterites are a typical formation of the Eastern Goldfields, and both types are represented in the Leonora district. The high level form, of a dark brown colour, is the more highly ferruginous; and is often of pisolitic appearance, or shows a brecciated structure at the base, due to the detrital rock fragments becoming re-cemented into the mass, which may be a compact impure ironstone.

The deposit now only occurs in the form of detached outliers, sometimes presenting a vertical cliff face from 15 feet to 20 feet in height (Plate I.); and where the original surface can be examined, the highest portions are found to be at an elevation of from 80 feet to 100 feet above the mean surface level. This corresponds with the observations in the Coolgardie Goldfield, where a sample was found to contain, as oxide, the equivalent of 25 per cent. of metallic iron, and one recently collected in the neighbourhood of Boogardie, as much as 51.67 per cent. and 11.46 silica.

The low level variety is of much greater extent, and between the areas occupied entirely by this formation and the more recent alluvium, it is often difficult to differentiate on a merely superficial

examination. The deposit is more of the nature of a ferruginous clay, which, by the development of concretionary structures, has become nodular, particularly in the upper portions, the iron ultimately appearing on the surface in the form of fine red dust and hard brown ironstone pebbles.

The origin of these laterites, both here and also in India, appears to have been a subject of some speculation; but of the deposits at present under discussion, while the low level varieties have in great part a detrital origin derived from the high level form, there is no evidence suggesting that the latter have been formed otherwise than *in situ*.

Underlying the deposits above described, and between them and the original rock masses beneath, there is almost always a thin stratum of calcareous material, locally called "cement," a formation which follows the contour of the rock surface and varies from a few inches to a few feet in thickness, and, being intensely hard, its removal requires the use of explosives.

This occurrence, also, is by no means uncommon, nor, indeed, limited to Western Australia, as a description of an almost identical occurrence has recently been published in the Transactions of the American Institute of Mining Engineers, Vol. XXXI.,* an article which supplies a comparison for those of our own State.

The material consists of an earthy limestone or travertine, often containing a breccia of rock fragments, and, like the other superficial deposits already mentioned, has been formed *in situ*. The cementing substance chiefly composing it has been derived from the decomposition of the lime-bearing minerals of the underlying rocks, and the process and formation one of solution and redeposition.

Finally, with regard to the superficial deposits as a source of gold—the first type only, i.e., that covering the granite schists on the east, can be said to have yielded alluvial gold in the sense of the term ordinarily understood in Western Australia.

The others have only served to hamper the operations of prospectors, and often, even when the proximity of an auriferous reef has been proved by the occurrence of gold in the surface boulders of quartz "floaters," its position has never been located. That such remarkable success has been met with can only be regarded as an argument in favour of further expectations.

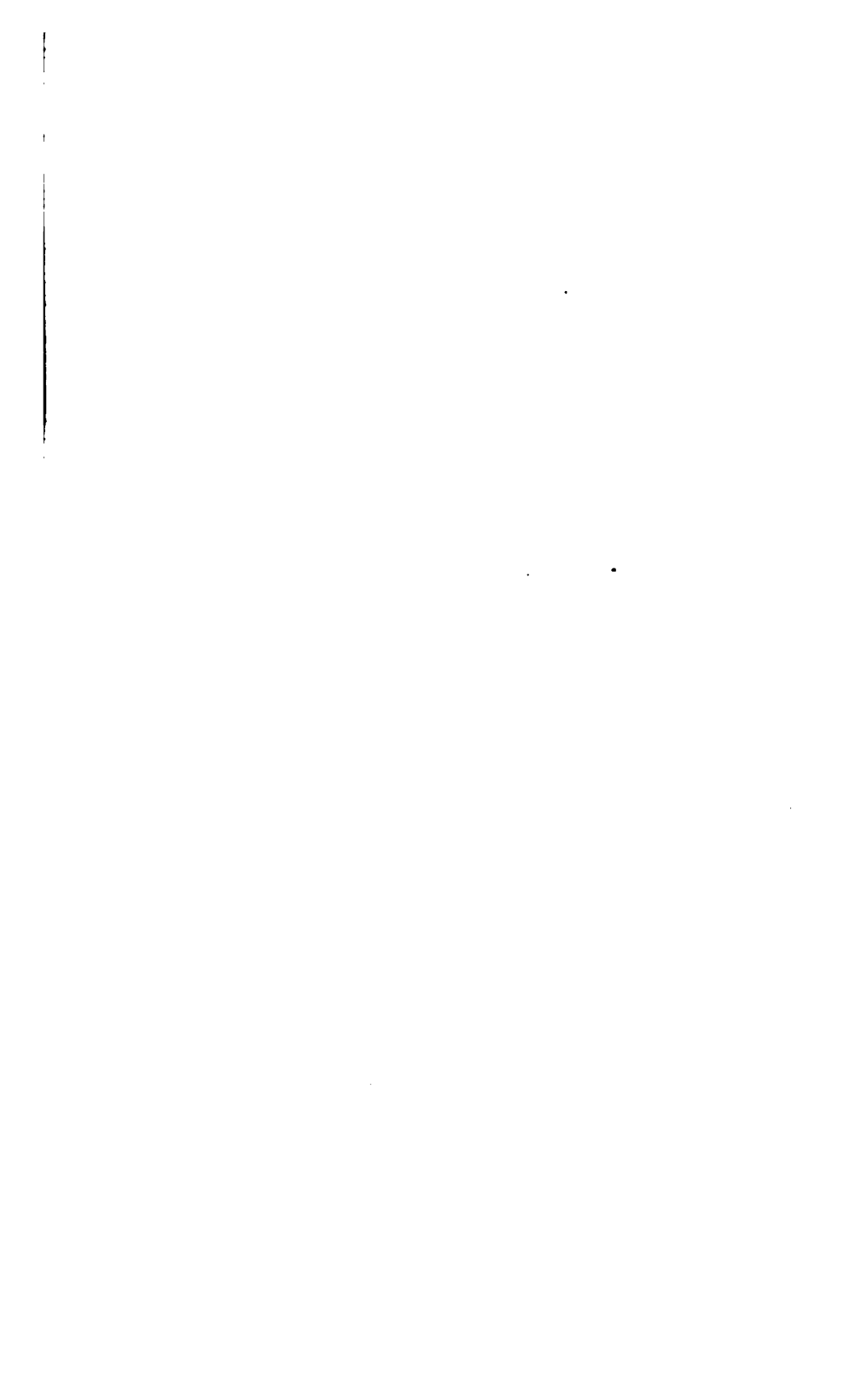
THE GREENSTONES.

The group of rocks comprising both massive and schistose forms to which the term greenstone is now being generally applied, have by far the greatest economic importance of any in the district; and with the extension of mining operations, an accurate knowledge of their extent and relation to the other rocks becomes second only

* The Caliche of S. Arizona, William P. Blake, Transac. Am. Inst. M.E., 1902, Vol. XXXI., pp. 220, 221.



Typical Outcrop of Banded-Quartz in Greenstone. One and a-half Miles South of Mount Larnoo



in importance to a knowledge of the ore-bodies within them, which yield from 60,000oz. to 70,000oz. of gold annually, or 95 per cent. of the total output.

The formation occupies a diagonal strip of the map, and must be regarded as a single area of basic rock, which has been more or less crushed, foliated, or completely converted into schists, the latter structure being on the whole the most usual, and to such schistose zones the auriferous reefs are almost entirely confined.

An examination of the area enables those portions which are occupied by the completely schistose rock, "greenstone schists," to be distinguished from those occupied by the massive and foliated greenstone; and furthermore, to the recognition of more than one variety of basic or ultra-basic rock; but not only is any further separation impossible, but, for reasons already stated, no satisfactory evidence is available with regard to the geological relation of the several varieties.

The greenstone schists are most largely developed on the outer margins of the main belt, in juxtaposition to the granite rocks, and, while the middle portion is occupied more or less by massive rocks, form two fairly well defined strips extending the whole length of the map. Those on the western side contain nearly all the important ore-bodies, and are of nearly the same composition, and similar in their characteristics, to the schists derived from similar rocks, "chlorite schists," occurring elsewhere.

The greenstone on the eastern side of the belt is found in an even higher state of metamorphism; a considerable development of the remarkable banded and hematite-bearing quartz forming one of the most noticeable features of the district. Along the summit of the ridge extending from Mount George to Leonora, and thence to Lake Raeside, outcrops of this quartz are found in the form of bands, or lenses, from 10 to 50 chains in length, and from 1 foot to 100 feet in thickness; and projecting several feet above the surface in the form of parallel-sided bars. (Plate II.)

They follow the general dip and strike of the schists, which have been altered by leaching and other processes for a considerable distance on either side; and appear to be similar to those at Bardoc, and to the occurrences mentioned in several reports on other goldfields, where their position is ascribed to "an old fault or line of joints along which the greenstones have been highly foliated." In the Boogardie and Lennonville Districts* they are auriferous, or associated with the auriferous deposits.

Their ultimate form seems to be due to a lode-forming process in the zone of weakness above referred to, but except in one instance at Leonora—"The Savannah Lode"—gold has taken no part in their mineralisation.

Specimens can be taken from the same outcrop of white quartz, of a banded quartz, and of a dark blue or grey compact variety

* Lennonville, Mt. Magnet, and Boogardie, Bulletin of the Geological Survey of W.A., No. 8, pp. 16, 17; C. G. Gibson. Perth: By Authority, 1903.

having in a hand-specimen the appearance of a felsite; under the microscope, however, slices from specimens [5101, 5102, 5222]* appear wholly as minutely crystalline quartz, containing a little iron oxide; the different appearance being due to the arrangement of the latter in bands, or in the blue grey variety to a more minute quartz mosaic and a more even arrangement of the iron.

The massive and foliated greenstone occupies, roughly speaking, the centre of the greenstone belt, being much more prominent at the northern end than at the southern end of the field, and an examination of the outcrops for specimens, which might serve as a guide to the original nature of the rock, does not furnish satisfactory evidence, since in almost every instance the rock is too decomposed for microscopic examination.

The best preserved specimen [5088]* consists of decomposed hornblende with plagioclase, and has been essentially a hornblende rock, while in sections of the others, which are all more or less crushed, the ferro-magnesian mineral shows complete conversion into chlorite; and the rock slices under the microscope are similar in appearance to those cut from specimens of the greenstones occurring at Coolgardie and Kalgoorlie, which have already been described in detail.†

One specimen only need be referred to [5088], which is in a very fresh condition, the rock being a diabase consisting of ophitically-arranged plagioclase and augite. I think it probable, however, that this rock is of later age than the basic rocks elsewhere. The specimen was taken from an outcrop of large round boulders occurring in an area of greenstone near the junction of the telegraph lines to the north-east of Leonora, and the outcrop itself occurs on a flat, and is surrounded by superficial deposits; but the remainder of the area, of which an examination is possible, consists of a rock similar to that occurring elsewhere.

THE GRANITIC ROCKS.

The existence of natural boundaries, as well as the considerations already referred to with regard to the greenstones, renders it advisable to similarly separate the granitic rocks into subdivisions of massive or foliated and completely schistose, though rocks are found grading from one type to the other.

The massive and crushed rock in which the original granitic structure can be recognised lies on the west, forming as it were a buttress, against which has been thrust the more schistose country to the east. Mount Leonora, with an elevation of 250 feet, forms a striking example of an intermediate stage of crushing and alteration (Plate III.), the rock having assumed a laminated form due to the pressure and weathering into large, more or less, rectangular blocks. Other small areas occur to the north and south, and appear—the

* The figures in heavy type [5088] throughout this report refer to the numbers of the specimens as entered in the Departmental Collection Register.

† Notes from the Departmental Laboratory, Geological Survey of W.A., Bulletin No. 6 pp. 62, 63. E. S. Simpson. Perth: By Authority, 1902.



Mount Leonora.—Outcrop of Crushed Granite; Dip, 55 degrees East.



southernmost one, at least—to be completely included in the greenstone; but owing to the general leaching and alteration which has taken place, it is difficult to determine this point with certainty. The relation of these rocks to the greenstones has already been referred to on page 17.

Outcrops to the west are few, but the specimens collected show the predominating rock to be a gneissic granite; and the ferromagnesian mineral, of which it appears to contain in some cases very little, was no doubt chiefly a dark mica.

The area to the east is distinguished from that to the west by the original form being in no case recognisable, and also by the extent to which the rocks have been effected by the agencies of decomposition. The result appears to be general, but there is a zone within the formation in which the process has continued to a very great depth. The original rock comprising this zone consisted, in its metamorphosed form, of a white fine-grained micaceous schist, and no doubt several varieties of granitic rocks occurred in the area; but the chief development has been that of a porphyry.

Sections Nos. 410, 411, of specimens [5096] and [5097] show under the microscope a minutely crystalline base with porphyritic quartz, No. 411 showing both porphyritic quartz and felspar—a quartz felspar porphyry. As far, however, as any evidence of relative geological age is concerned, these schists must be classed with the granites.

The following table gives a series of analyses made in the Survey Laboratory, under the direction of the Mineralogist and Assayer, of different varieties of the rocks referred to above:—

Table of Analyses of Rocks from Leonora District.

	G.S.M. 5,069	G.S.M. 5,068	G.S.M. 5,067	G.S.M. 5,066	G.S.M. 5,099	G.S.M. 5,064
SiO ₂ ...	47·70	50·98	42·17	53·09	76·22	76·71
CO ₂ ...	1·35	Nil	6·70	6·33	Nil	...
TiO ₂ ...	·52	·79	·55	·98	·86	·66
H ₂ O (Comb.)	6·62	1·08	2·97	·56	3·72	·24
Na ₂ O ...	·43	4·09	·45	8·09	·08	·07
K ₂ O ...	·38	·10	·26	·03	2·01	·11
MgO ...	22·49	4·70	24·71	3·36	·70	·06
CaO ...	·69	9·70	4·06	5·16	·66	·56
MnO ...	1·38	1·25	·55	...	Trace	...
FeO ...	7·38	8·35	8·18	1·73	...	...
Fe ₂ O ₃ ...	1·60	·87	...	4·36	3·52	1·70
Al ₂ O ₃ ...	9·99	17·09	9·29	16·03	12·55	20·08
Fe ...	...	·09	·13	·12	...	...
S ...	...	·10	·15	·14	...	...
H ₂ O (Hyg.)	·21	·05	·02	·05	·32	·21
	100·69	99·24	100·19	100·03	100·64	100·40
Sp. Gr. ...	2·06	2·95	2·85	2·73	2·47	2·81

- 5089.—Schistose Greenstone (talcosc). Tower Hill Lease No. 4387. Analyst, C. C. Williams.
- 5088.—Massive Greenstone. Tower Hill Lease No. 4387. Analyst, C. C. Williams.
- 5087.—Schistose Greenstone (chloritic). Tower Hill Lease No. 4390. Analyst, C. C. Williams.
- 5086.—Altered Greenstone. Half-a-mile East of Mount George. Analyst, C. C. Williams.
- 5090.—Massive Greenstone. Quarter of a mile north of Pride of Leonora mine. Analyst, C. C. Williams.
- 5084.—Crushed Granite. Near Trigonometrical Station, Leonora. Analyst, C. C. Williams.

Distribution and Character of the Ore Deposits.

With the system of mapping adopted, the ore deposits conveniently fall into four classes, according to the rocks in which they occur, but there is similarity throughout in a lenticular habit, and particularly in the tendency to follow the planes of foliation of the containing rocks. The term "bedded-vein," however, is in no way applicable.

In the granitic rocks to the west there is only one representative in the "Trump" mine; while at the junction of these rocks with the greenstones, where the remarkable masses of quartz ("Quartz Blows") have been developed (Plate IV.), "the Forrest" and "Tower Hill" deposits alone are auriferous, the latter being of very great size.

The "Leonora Gold Blocks," "Sons of Gwalia," and "Gwalia South," with numerous other smaller occurrences, are examples of lodes and reefs wholly in the greenstone; while the "Lady Lena," "Ironstone" (Pride of Leonora), and "Sons of Australia" (Camel leases), are deposits in the granite schists.

There is a great variation in the thickness of the reefs, which in every case consist essentially of quartz: with, in the unoxidised portions, both iron and copper pyrites as associated minerals, the latter being regarded by prospectors as an indication of richer stone.

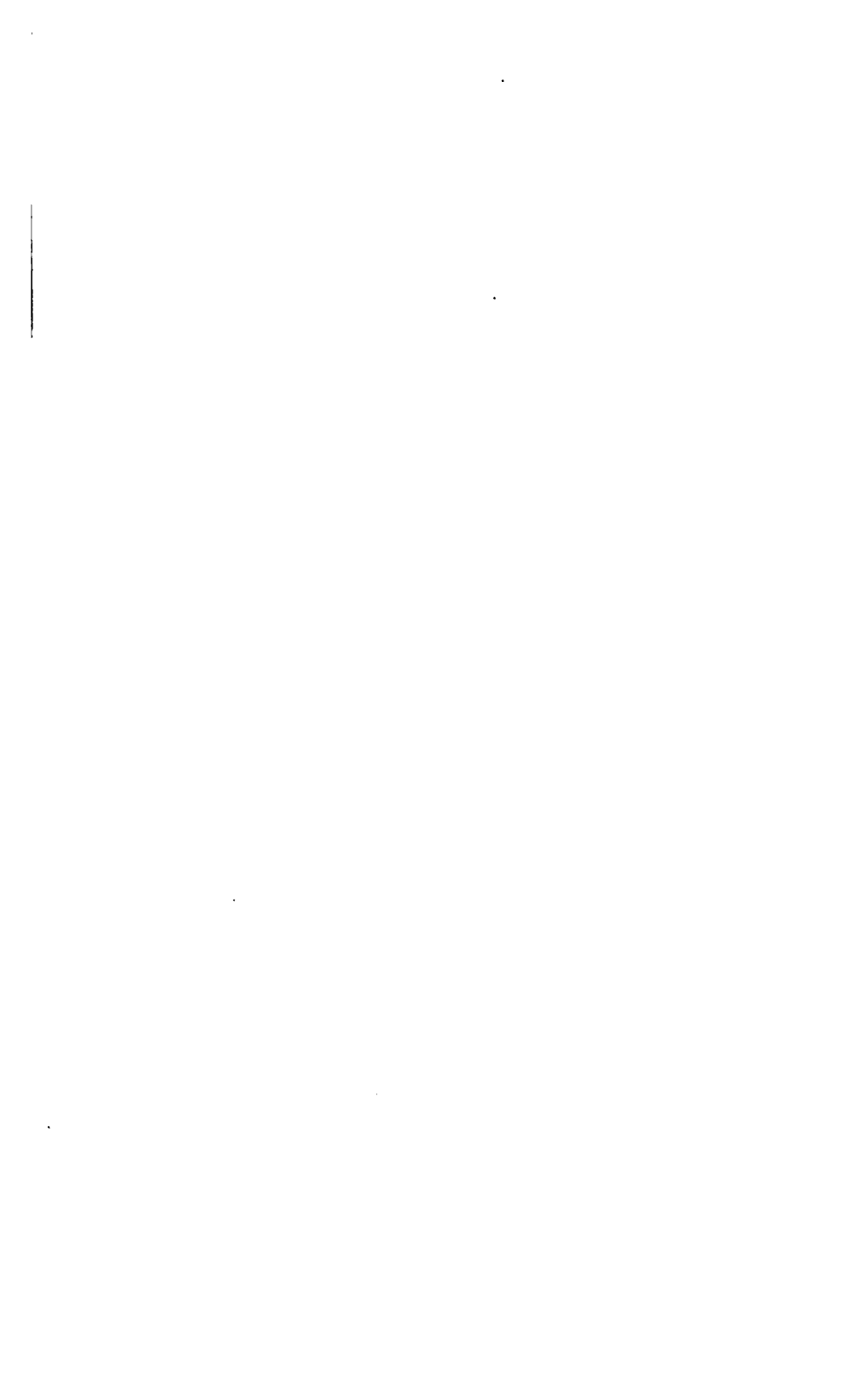
So far as their permanence at a depth is concerned, the workings, as a rule, have been entirely confined to the oxidised zone above water level; but from the information available, there is no reason to anticipate any failing in this respect, and in the Sons of Gwalia—a somewhat isolated occurrence in this district, however—development is being satisfactorily carried on at a depth of over 1,000 feet.

Of alluvial deposits, there are at most only two examples—that known as the "Specking Patch," at the north-eastern corner of the map, and a small area close to the Forrest mine. With regard to the former, where the workings extend over 30 acres, there is very little information obtainable, except that a good deal of alluvial gold was obtained, the largest piece being a nugget of 32ozs.

2 26.



Outcropping Quartz Masses, Tower Hill.



A great number of shafts were sunk through the superficial deposit just to the north of the Forrest mine, and it appears that several of these with the most easterly situation "bottomed" on a deposit precisely similar to the "pug" obtained in the so-called deep lead at Kanowna.*

This material was somewhat stratified in appearance, and in some places the joint surfaces showed films of gold, which I have no doubt was of secondary origin and derived from the northerly extension of the Forrest reef.

The Mines.

THE TRUMP MINE.

Lease.	Total Ore.	Total Gold.†	Average Grade.
Nos. 263c, 482c	tons. 11,999'35	ozs. 11,296'28	ozs. '94

† To end of 1903.

The leases are situated three miles north-west of Leonora, adjacent to the Lawlers Road on the western side, and the discovery of gold thereon, one of the first finds in the district, was made by Messrs. Collins, Armstrong, and Roach, in 1896. Some remarkably rich ore was obtained near the surface, the first parcels being crushed at Menzies, and a syndicate, comprising most of the original prospectors, at present own the property.

The deposit is interesting, both from its form and position, as it is the only payable one which has so far been found to the west of the Greenstone.

The strike of the outcropping portion of the vein is 66 degrees east of north, and the average dip about 12 degrees to the south; but farther from the surface, just above the water level, there is evidence of a steeper dip.

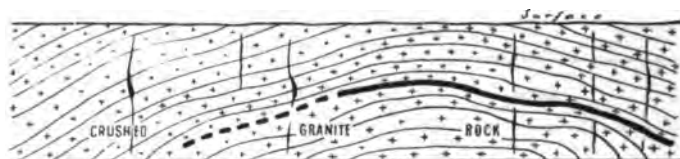
The prominent feature in the mine consists of a main quartz vein following the planes of foliation of the crushed granitic rock, which has been squeezed up, and a system of joints developed in the form of an anticline. Though the deposit generally follows one of the main partings of the rock, occasionally a portion has taken an upward course and finally followed a parallel parting above, so that the workings are very irregular, and it is difficult, without the aid of a plan, to trace its general course.

An outcrop is visible for a short distance to the east, but no trace of the reef could ever be found near the surface to the west of the main underlay shaft.

*Report on the so-called deep lead at Kanowna, Bulletin No. 3 of the Geological Survey of W.A., pp. 31, 32. T. Blatchford. Perth: By Authority. 1899.

The reason for this is evident on an examination of the workings, which also leads to the conclusion that the vein is in the form of a saddle, the axis of which has an east and west direction, and a slight dip to the west. At 250 feet, in the shaft, a long drive to the west, beginning with a slight upward incline, follows the vein, which at first had a southerly dip, but becoming quite flat and then assuming a northerly dip, there is a considerable fall to the end of the drive; which has thus passed over the cap of the saddle about 30 feet below the surface (Fig. 2).

FIG. 2.



SECTION OF REEF ABOUT 2½ CHAINS S.W. OF MAIN SHAFT, TRUMP MINE.

The anticlinal tendency can be well seen on examining the rocks near the working shaft, and in an old shaft just to the north the reef appears to have been cut at a depth of 23 feet, lying in an almost horizontal position (Fig. 3).

FIG. 3.



SECTION OF REEF AT MAIN SHAFT — TRUMP MINE

As well as these indications pointing to the existence of a northern leg, the formation of the deposit in a fissure, which owes its shape to the contortions which the gneissic rocks have undergone, suggests the possibility of an arrangement similar to that of the ore bodies in true saddle reefs. Prospecting operations, so far, have been chiefly directed towards testing the continuation to the south of the main vein already worked.

In this respect it may be mentioned that a water shaft about 200 feet south of the outcrop, after passing through the main vein at 14 feet, cut at 50 feet a small gold-bearing vein apparently dipping in the same direction and at a greater angle (65°). In addition to shafts, three diamond drill bores were put down at a



Open cut showing Hanging Wall of Lens and character of Quartz, Tower Hill.

mean distance of about 15 chains to the south, but the particulars and results regarding them are only known to Messrs. Bewick, Moreing, & Co., by whom the work was undertaken.

Besides those following the foliation of the rock, there is a system of vertical or highly inclined veins, with a similar east and west strike; but apparently they do not carry payable gold, as they have in no case been removed.

Work has been carried on from an underlay shaft following the deposit for 400 feet, and at 240 feet the main vein is divided by a "horse" of less crushed granite; the lower arm having been followed and worked. Levels have been driven to the east at distances of 100 feet, 250 feet, and 300 feet, and to the west at 100 feet, 250 feet, and 270 feet, the bulk of the stoping being on the east. Development work, however, is now chiefly on the western side of the shaft, and has, up to the present, been entirely confined to the portion of the deposit above water level.

The main quartz vein, which is sometimes several feet in thickness, is flanked by smaller strings and veins, and the ore obtained contains a good deal of decomposed rock, which carries gold, probably in the filling of the joints. This associated rock has a noticeably bad effect on amalgamation, and an examination by the Departmental Mineralogist of a sample of the ore [5232], taken from the battery floor, showed it to contain, in addition to the ordinary constituents of a granite, the minerals pyromorphite (phosphate of lead) and mimetite (arsenate of lead); to which, as well as the large proportion of kaolin present, the interference with the process is due.

THE TOWER HILL.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	oss.	oss.
Nos. 218c, 219c	3,597	1,122.05	0.33

*To end of 1903.

The Leases, which were taken up early in 1897 by a prospector named Breen, are situated one and a-quarter miles south of Leonora, just to the west of the railway line, and are at present the property of the "Octagon Explorers, Ltd.," by whom nearly the whole of the prospecting work has been done.

There are several remarkable features about the deposit, which forms the best example of the occasionally auriferous nature of the quartz masses in the district.

A reference to the map will show the position of the principal quartz bodies. They are generally in the greenstone schists almost at their contact with the granite, but instances occur in which they are situated wholly in the latter rocks.

Throughout them all there seems to be a strong tendency to a lens-shaped plan, but there is not much information, to a greater depth than 500 feet, bearing on the question of their form in a vertical section.

All in the vicinity of Tower Hill are said to carry gold, but the operations of the syndicate have been chiefly confined to those at the north end, which are so closely associated as almost to form one continuous deposit, with an average strike in a north and south direction and a dip to the East of 45 degrees, similar to that of the schists.

Fig. 1, Plate VII., shows the position and the relation to the granite and greenstone of the deposit worked by the Tower Hill Company, which is by far the largest of any, and attains a width of 80 feet measured horizontally in the deepest crosscut.

The whole width, moreover, is composed of white quartz, which shows signs of crushing, and consists of a series of more or less solid portions running in distinct bands, with the space between filled with a more broken variety, there being a rough system of parting planes, along which it is broken down in blocks. (Plate V.)

There is scarcely, if any, associated rock, except at the outside near the hanging wall, where thin laminæ of schist are found in the quartz, some of the surfaces showing signs of slickensiding and thin scales of gold.

Some of the quartz lenses or "blows" contain areas of quartz and dolomite, the latter being ferriferous, which gives it a red colour; and there are also traces of copper carbonates, though not in the main deposit, where the whole of the gold is in an amalgamable form.

The first work of the prospectors was a large open cut, but subsequently shafts were put down to about 75 feet (water level), and the quartz explored by a system of drives. (Fig. 3, Plate VII.)

The quantity and value of the ore obtained have already been stated; but as regards the distribution of the gold in the deposit, the question is a difficult one to decide. Some information relative to its continuance has been obtained by a bore put down on the eastern side, which cut the hanging wall of the quartz at a depth of 366 feet 6 inches, and passed through the footwall at 501 feet 6 inches.

It appears that at this point the gold was not evenly distributed, but chiefly occupied more or less definite positions in the upper half and lower half of the quartz body. Further than this there is no evidence bearing on the question.

A reference to the map will indicate the numerous other quartz masses, the only similar deposit of importance being that known as the Forrest.



Leonora Main Reef, showing Outcrop and Workings.

THE FORREST.
(*Leonora Main Reefs.*)

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 210c, 253c	tons. 843	oss. 1,297'58†	oss. 1'46

* To end of 1903.

† Includes 66·25 ounces from specimens.

The leases are situated two miles north-west of Leonora, and about a quarter of a mile west of the Lawlers road.

The reef was discovered by Messrs. Smith and others during 1896, and these original prospectors obtained most of the gold which the mine has yielded; the ore being crushed at the North Star battery, Mount Malcolm. They worked to a depth of about 60 feet, when the rather large supply of water put an end to their operations. The property then passed into the possession of a Perth Syndicate, finally the Leonora Main Reefs Company.

The deposit which has also a north and south course, but is almost vertical or with a slight tendency to a westerly dip, is of similar type to that of the Tower Hill, though rather more of the nature of a large quartz "reef."

It occurs in the same manner almost at the junction of the greenstones and granitic rocks; in fact, passes from one to the other, the reef at the south end being wholly in the granite; while in the vicinity of the workings in the greenstone, and in some places follows the junction.

In addition to a large reef more or less centrally situated, there are others of smaller size and what would seem to be detached masses; but satisfactory information with regard to the form and extent of the deposit cannot be obtained in the old workings, where the rocks are much broken and decomposed.

The present owners found it necessary to sink a new vertical shaft at the north end and just to the west of the outcrop, but owing to a temporary cessation of operations the water was allowed to accumulate, and the new workings were inaccessible. (Plate VI.)

From the bottom of this shaft, which was sunk to 155 feet, the reef was intersected by a crosscut 27 feet east, and has been explored by drives to a small extent at that level. When sinking was discontinued, the shaft was still in the greenstone schists.

In the early stages of the mine some remarkable specimens of gold in quartz were obtained, especially from Lease 210c, and these were secured by the West Australian Government for the Paris Exhibition.

Besides ordinary white quartz, the ore obtained has contained a considerable proportion of quartz associated with asbolite (an oxide of manganese containing several per cent. of cobalt), to which in some portions a prevailing black colour is due.

THE SONS OF GWALIA.

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 190c, 207c, 353c ...	tons. 389,061	ozs. 299,226·07	ozs. 0·76

* To end of 1903.

The leases are situated $2\frac{1}{4}$ miles south of Leonora, and the original prospectors were Messrs. White, Glendenning, and Carlson. The official record contains an entry of lease 190c, which includes the outcrop, having been applied for on the 2nd June, 1896.

Development of the property has steadily proceeded since its purchase by Mr. G. W. Hall, in November of the same year, and the present ownership is registered under the title of the "Sons of Gwalia, Ltd."

The deposit is by far the most important of those situated in the Greenstone, and apart from its size has many distinctive features which separate it from others in the district; not so much as regards morphological characteristics as internal structure and mode of formation. It falls into the class which Mr. A. Gibb Maitland has described † as "impregnations in zones of rock," which, he says, "form the most interesting and possibly the most important source of the precious metal in Western Australia." Further, "that they are merely portions of a large mass of rock, which in consequence of dynamical agencies has permitted the free circulation and deposition from mineral solutions; and they are characterised by having no well-defined walls, the limit of the deposit being determined by the decrease in the assay value of the rock to a point at which it ceases to pay the expenses of working. They are generally known in this country as "lode formations," and will herein be referred to exclusively as "lodes" in contradistinction to the terms reef and vein used in other cases."

The Sons of Gwalia lode, the course of which is 16 degrees east of north and the mean easterly dip 45 degrees, occurs entirely in the greenstone schists; and is made up of numerous mineralised quartz veins of varying size and of distinctly lenticular shape.

These quartz veins have been developed over a zone of considerable width, the rock itself being also impregnated with minerals

† Mineral Wealth of W.A., Bulletin No. 4 of the Geological Survey of W.A., pp. 26, 27. A. Gibb Maitland. Perth: By Authority, 1900.

containing gold; but the actual lateral extent of the lode formation, except on the east where it is limited by a tabular mass of less crushed rock, cannot be accurately defined.

Mining, however, has been entirely confined within the formation to three "shoots" of payable ore; of such size and in such position as to be workable by a separate system of stopes; and in each of which the mineralised veins are so closely associated as to form more or less parallel ore bodies of compact quartz.

These shoots of ore are generally known as the "A" or "Main Lode," the "B," or "Eastern Lode," and the "Western Vein" a small parallel shoot which has appeared on the west of the "A" shoot, with some persistence, and has been mined in places as far as the No. 8 level. (Fig. 4, Plate VII.)

Each zone of highest value within the shoots, composed of an aggregate of the quartz veins, appears itself to have assumed somewhat of a lenticular form; having a core or lens of more highly mineralised quartzose material from one to two feet in thickness, and extending laterally from 20 feet to 60 feet—a "lens of ore."

A number of these lenses connected by a chain of values follow each other roughly in the same plane, and together with the impregnated formation containing them, giving a total stoping width which has varied from 6 feet to 30 feet, have made up the ore bodies of the mine.

Owing to their development, however, to a greater or less extent throughout the whole of the lode, and the fact, moreover, that a certain series of them only carry the payable values, the actual course of the shoot can only be followed by an elaborate and careful system of sampling.

The "B" or eastern shoot was of greatest importance in the upper levels; and as regards its horizontal extent, though its northern end may have been reached, both its limit of depth and southern extent are still uncertain. Until quite recently it had only been found on the one side of the shaft and explored to the Nos. 6 and 7 level. Compare figs. 1, 5, and 4, Plate VII.; but I believe the position has recently been located elsewhere.

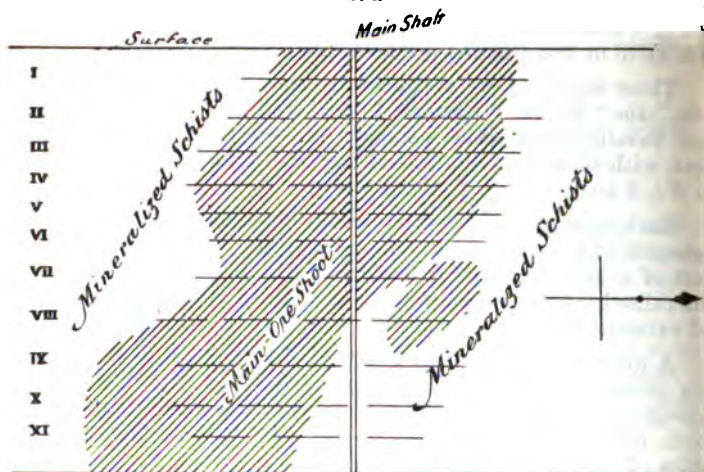
The westerly shoot has only been worked here and there in the upper levels, and would seem to be more of the nature of an off-shoot making its appearance at a greater depth in the form of a "footwall vein" of the "A" shoot, which in such places attains a very great width.

The "A" or main shoot forms the most prominent feature of the mine, and is that on which attention is now being chiefly centred. In the upper levels it was worked on both sides of the shaft, and is now being worked on the southern side at the deepest level in the mine, No. 12.

The extent of the workings on this ore body has brought to light several characteristics which may also be appropriate to the others, particularly the southerly progression of values.

As a greater depth was reached the shoot was found to have decided trend to the south, and the northern end, advancing at the rate of about 60 feet per "level," passed to the south of the shaft at about the No. 6 level, a habit which has been most consistent (Fig. 4.)

FIG. 4.



PLAN SHEWING SOUTHERLY TREND OF MAIN ORE SHOOT, SONS OF GWALIA.

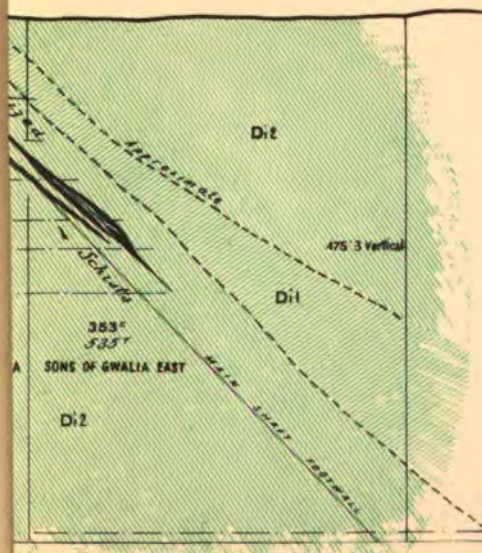
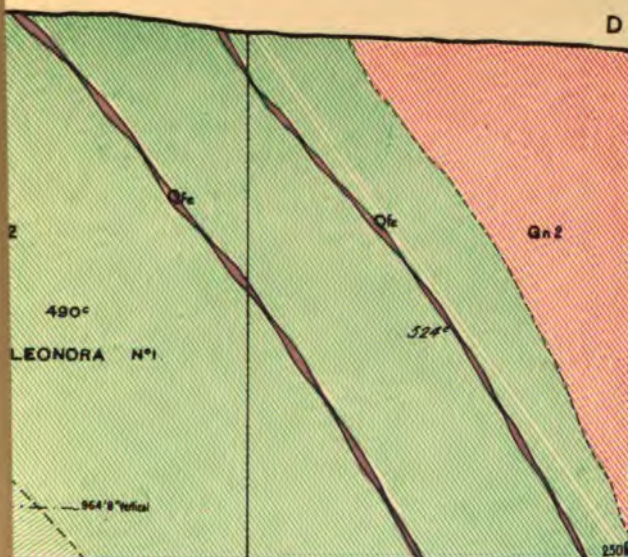
In the annual report of the directors of the company for 1902, the ore reserves in this shoot are given at 133,417 tons, and in the "B" shoot 9,071 tons, a total of 142,488; which, in June, 1903, had been increased to 188,623 tons, of average grade.

The deposit is worked from a main inclined shaft by means of levels driven roughly at intervals of 100 feet, the lowest at present being the No. 12, at a vertical depth of 1,056 feet.

The upper portion of the shaft approximately followed the main shoot, but owing to the somewhat flatter dip at a greater depth that ore body is now considerably to the east; and a main crosscut from the shaft is necessary to intercept it. The crosscuts are continued east until what is termed an "indicator vein" is met with—a small vein or string of quartz containing values, and apparently connected with the main shoot—and this is followed towards the south until the drive is carried into the main ore lens.

In order to save driving in the three lower levels a south-easterly direction has been given to the main crosscuts immediately on leaving the shaft.

The upper levels have been driven to the apparent limits of the ore, both to the north and south, but no very extended prospecting appears to have been done in search of an extension of the deposit, or the existence of another shoot, which, towards the north, is still



a matter of conjecture, though some light is afforded on the question of an extension of the lode southwards by an examination of the workings of the Gwalia South Mine. (Fig. 2, Plate VII.)

What appears without doubt to be a continuation of the Sons of Gwalia lode is being worked at a depth of about 187 feet; which would be at a level between the No. 2 and No. 3 in the Sons of Gwalia mine. At this point the shoot is considerably farther west than would have been expected, and has, moreover, assumed a course somewhat more east of north. There is also another small shoot about 80 or 90 feet east, the course of which, as far as can be judged from the workings, trends even more to the eastward; and if it continued thus would pass at this level into leases 380c and 353c. The ore bodies can only be examined in one place, however, and the surface is covered by the tailings dump and slimes pits. (Plate VIII.)

The ore, even in the most quartzose portions, has a crushed appearance, and portions of it separate along parting planes in which are thin laminae of chloritic schistose material, often showing thin gold on the surfaces. An examination of samples by Mr. E. S. Simpson, the Departmental Mineralogist, has shown that in addition to the predominating quartz and pyrites, calcite chlorite muscovite and acicular tourmaline are present as associated minerals.

When passed through the mill, the resulting pulp from which about 65* per cent. of the gold is obtained by amalgamation, contains 53* per cent. of sands, 45* per cent. of slimes, and 2* per cent. of concentrates. The concentrates are reserved for separate treatment.

The sands and slimes, after leaving the concentrators, are elevated to spitzkasten, which returns to the machines a certain per cent. of coarse sands and concentrates; the remainder passing to the collecting vats, the slimes through slat-grates to the settling dam.

The sands collected in the vats, after being treated with a preliminary wash, are dumped into other vats beneath, and given appropriate cyanide treatment. The concentrates collected from the tables are ground in wheeler pans, and pass thence to agitators, when, after filter-pressing the resulting product of agitation with cyanide solution, a good extraction is said to be obtained, or, summing the various processes, a total extraction of 85* per cent.

The ore is mined and thus dealt with by 50 stamps, with a duty of 5.5 tons, and at a cost to the company of £1 0s. 7d.* per ton.

* Figures supplied by manager, August, 1903.

THE EASTERN
(Gwalia South).

Lease.	Total Ore.	Total Gold.*	Average Grade.
No. 198c	tons. 302	ozs. 36317	ozs. 120

* To end of 1903.

The lease is situated immediately to the south of the Sons of Gwalia, No. 190c, and adjoining it.

The outcrop was discovered shortly after the Sons of Gwalia by a prospector named Duffil, and a lease taken up, which, however, was chiefly under exemption or only worked intermittently until the end of 1902, when the present company was formed in Melbourne.

The deposit is situated in the schists, in a precisely similar manner to the Sons of Gwalia, of which, as already explained, it is no doubt an extension; and is limited in width on the east by a similar mass of greenstone, also, probably, a continuation of that already mentioned.

The character of the lode formation and the ore are also identical, the latter being sent for treatment at the public battery.

The development work on the lode amounts to 207 feet of sinking, shaft and winze, and about 116 feet each of crosscutting and driving, the deepest level being at 187 feet.

The workings are situated 236 feet from the boundary, so that, if the lode continues at its present dip to the east, it will, as a depth is reached, pass out of the lease into the Sons of Gwalia Extended, Nos. 584 and 380, held by the Sons of Gwalia Company.

So far, however, it has only been explored at the northern end of the lease, which is 12 chains square.

Farther south, a considerable amount of prospecting has been done in search of a continuation of this lode, and leases were taken up and shafts sunk for more than two miles; but no work has been done for some years, and it is difficult to collect facts, either with regard to the extent of the operations or the success met with.

It is advisable, however, in a report of this kind, to record the information obtained, and most interest attaches to the leases known as the "Star of Gwalia" and "Star of Gwalia South":—

THE STAR OF GWALIA AND STAR OF GWALIA SOUTH (LEASES
Nos. 478c, 479c).

These leases are situated half-a-mile almost due south of the Sons of Gwalia, and were taken up and prospected, I believe, by Mr. G. W. Hall. It is said that, both by sinking and with the aid





The Gwalia South Mine working the Southerly Extension of the Sons of Gwalia Lode, showing relative position of two Mines.

of diamond drills, the country was explored to a depth of at least 1,500 feet, and in the Star of Gwalia there were crosscuts at water level from the east to the west boundary of the lease, without success as far as the Gwalia lode was concerned, or indeed a payable formation.

What has no doubt been the deepest shaft, on Lease 479c, appears to have been sunk on the same zone of massive rock met with in the workings to the east of the Sons of Gwalia lode, which it entered at a depth; and while it is not surprising that the shallower shafts did not intercept the lode, if it exists, it appears most probable that the deeper efforts were mis-directed by an expectation of finding it considerably farther east than might now be expected: a supposition to which the evidence from its appearance in the Gwalia South mine strongly points.

Immediately to the north of the Sons of Gwalia there have also been a number of leases taken up and shafts sunk in the greenstone schists, of which, however, but little information is obtainable.

THE ROCHESTER (LEASE No. 450c).

This lease is situated 36 chains north of No. 190c, and a shaft was sunk by an Adelaide company, I believe, to a depth of 300 feet, but without any result. It is now held by the Sons of Gwalia Company, and used by them as a water supply shaft.

North of the townsite of Leonora are further deposits in the greenstone, some of which, like those of lesser importance to the south, are only worked intermittently or abandoned.

THE SAVANAH.

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 621c, 786c, etc. ...	tons. 121	ozs. 85'98	ozs. 0'71

* To end of 1903.

No. 621c and the original leases, 786c, 787c (now voided), are situated about 75 chains north-west of Leonora, on the eastern side of the Lawlers Road.

There are shallow shafts and workings for more than a mile along the line of reef, but work has never been more than superficial and intermittent.

The deposit occurs in the greenstone schists, with a corresponding strike of 32 degrees west of north, the dip of 70 degrees being to the east. It is not very large, its chief characteristic being in the ore, a highly ferruginous banded quartz, which has already been mentioned in connection with its relation to the larger masses of similar variety.

THE GREAT BOSTON.

Lease.	Total Ore.	Total Gold.*	Average Grade.
No. 546c	tons. 279	oss. 113'45	oss. 0'40

* To end of 1903.

This lease is situated a mile north-west of Leonora, on the western side of the Lawlers Road. It has been abandoned for some years, so that little information with regard to it can now be obtained.

There appears to have been a deposit of the character of a "lode formation," and some extensive development work was undertaken by Mr. G. W. Hall, especially at the 120 feet level, where some long crosscuts were put in; but considerable quantities of water were met with, and the gold yield shows that the ore obtained was of low grade.

The option held by Mr. Hall was abandoned, and no further work has since been done. The lease is now held by the Sons of Gwalia Company as a reserve water area.

THE COMMONWEALTH.

(Grey Lode.)

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 954c (711c) (556c) ...	tons. 199	oss. 85'60	oss. 0'37

* To end of 1903.

These leases and others have been taken up and forfeited at different times, enclosing the same area, but with corner pegs in slightly altered positions.

No. 954c, now known as the Commonwealth, is situated one and a-half miles north-west of Leonora, and the deposit, which was one of the first worked in the district, has received only occasional attention from different prospectors.

The reef is in the greenstone schists, having a strike about 9° west of north, and an average easterly dip of 35°. The quartz composing it has a greyish colour, and varies from one to four feet in thickness, with a considerable proportion of sulphides even near the surface.

An underlay shaft follows the reef for about 40 feet, in which distance it appears to be faulted in two places, and the eastern portion dropped about 10 feet. There are, besides, several vertical

shafts sunk on the back of the reef, and the prospectors working there at present intend to sink another to intercept it at a rather shallower depth.

THE LEONORA GOLD BLOCKS.

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 195c, 196c	tons. 6,144	ozs. 9,746.53	ozs. 1.58

* To end of 1906.

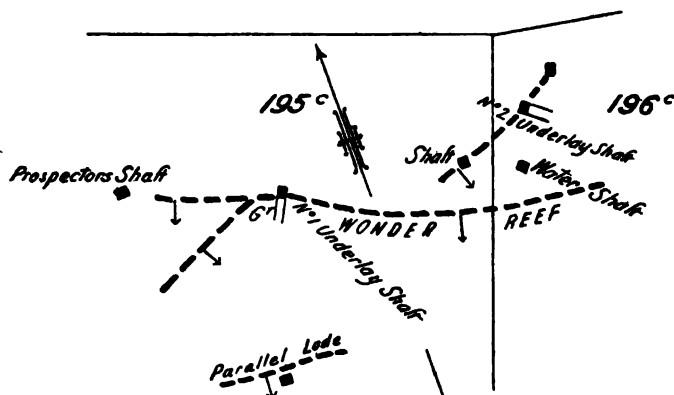
The leases are situated just to the east of the Lawlers Road, four miles north-west of Leonora, and the deposit was one of the first discovered in the district, in 1896.

Lease 195c was taken up on the 3rd June, 1896, by a prospector named McPhie, an employee of a Perth syndicate, who are the present owners of the property.

Only one or two small pieces of quartz were found near the outcrop, the actual discovery of which is attributed to a black boy attached to McPhie's party; and the reef was afterwards located beneath the cement.

Two main reefs have been opened up, situated in an area of massive and crushed greenstone, and on Leases 195c and 196c (Fig. 5).

FIG. 5.



PLAN SHEWING POSITION OF PRINCIPAL REEFS LEONORA GOLD BLOCKS.

That situated on Lease 195c, originally known as the Great Wonder, was worked from the No. 1 underlay shaft, and has a mean strike of about 10 degrees south of east, but there are several curves and branches.

As exposed in the shaft, the deposit consists of a quartz vein, centrally situated in a zone of crushed greenstone, which contains smaller parallel quartz veins; and the whole formation, which dips at 55 degrees to the south-west, is enclosed by almost parallel walls of massive greenstone.

The zone of crushed rock, with a width in one part of the shaft of about two feet and in many parts of the workings considerably more, is decomposed and mineralised.

The character of the reef on Lease 196c, which is being worked at present from No. 2 underlay shaft, is somewhat similar, except that the containing rocks are completely foliated. Its approximate strike is about 15 degrees north of east, the dip from 25 degrees to 30 degrees to the south of east; the main quartz vein and the accompanying formation have a payable width of from one to three feet.

Its form, however, is very irregular, and being interfoliated with the greenstone it follows the contortions of the rock, and not unfrequently splits up into two portions, which for some distance follow different parting planes. Often a kind of saddle is formed, and in such cases the upward and downward legs are generally found to be rich, while the ridge or cap is impoverished. When the deposit splits in this manner, it is sometimes difficult to know until some work has been done which is the branch and which the main vein, as the former sometimes contain high values.

Passing through the workings are two felsite dykes, which can be traced on the surface with a parallel course from the south-east to the north-west corner of the lease, and have a width of from 15 to 20 feet.

Known as "white lodes," they dip to the east at about 60 degrees, their strike being almost at right angles to the direction of foliation of the greenstone.

The continuity of the reef, however, is not broken, and at the intersection the felsitic rock is said to be mineralised and auriferous for a small distance on either side of the vein.

Outcrops of similar rock are to be seen on the surface to the south and the north, but it is not possible to trace them for any great distance, owing to the prevailing superficial deposits. While the general characteristics are those of a dyke, and the rock slice of the least decomposed specimen obtainable has the appearance of a felsite, the subject cannot be left without reference to the innumerable metamorphosed varieties of the greenstones found elsewhere, one form somewhat similar to the rock in question, and to which a connection might possibly be traced when further information is obtainable.

Quite recently another reef carrying gold was discovered and a lease taken up just to the south of the Leonora Gold Blocks, and in addition to the two already mentioned there is another reef on

Lease 195c, known as the "parallel lode," from its approximately similar course to that of the Great Wonder. The dip is also in the same direction, but the vein is highly inclined and the outcrop is about four chains west of the No. 1 underlay shaft.

Messrs. Bewick, Moreing, & Co. commenced the work of sinking a diamond drill bore to the west of this outcrop, the intention apparently being to intercept both this reef and the Great Wonder; but there is no information obtainable either with regard to the results obtained or as to whether the intention was ever completely carried out.

There has been a considerable amount of development work, especially from the No. 1 underlay, which follows the dip of the vein for 150 feet, and from which levels have been opened out both east and west at 50 feet, 95 feet, and 150 feet; in all about 1,300 feet of driving.

Development from the No. 2 underlay shaft is being chiefly carried on at a level corresponding to the upper one on Lease 195, the intention being to connect the two and ascertain whether the reef is a branch of the main reef. A number of shafts have been put down by prospectors at the north-west corner of Lease 195, in search of a continuation of the Great Wonder, but without success, the majority of them being sunk in the granitic rocks to the west.

So far the ore, nearly all obtained from the oxidised zone, has been amenable to treatment without special appliances; but, at a greater depth, it appears that its character will be that of a sulphide ore. The bulk of that obtained has been dealt with at the mine by a 10-stamp battery, working at present with a duty of 2·7 tons, and there is a small cyanide plant attached.

THE CLARENCE.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
Nos. 908c (731c) (465c) ...	314·75	521·49	1·65

* To end of 1903.

The leases are situated five miles north-west of Leonora, and about half-a-mile from the Lawlers Road, on the east side. The original prospectors of the claim, in 1897, were Messrs. Adams, Ferry, and Boatright, by whom it was abandoned, and shortly afterwards a considerable amount of gold was obtained by other prospectors.

There are three veins or reefs, having an approximate parallel strike of 52 degrees east of north, and a southerly dip varying from 45 degrees to 85 degrees. The rock in which they occur is in the upper portions decomposed and completely converted into a clay, which in places shows evidence of an original schistose structure and has no doubt been derived from a basic rock.

The centrally situated of the three veins is that on which the most work has been done, and there are a number of shallow shafts and surface workings along the outcrop; but the bulk of the prospecting was done from a vertical shaft which cuts the reef at a depth of 60 feet, just above water level. The vein has a lenticular habit; and the ore, essentially a quartz, shows often a good deal of free gold.

The second parallel vein of the same character which has been recently opened up is about 50 feet south, and though small, has returned good results.

THE RICHMOND.

Lease.	Total Ore.	Total Gold. *	Average Grade.
No. 730c	tons. 124	ozs. 137'31	ozs. 1'10

* To end of 1903.

This lease is situated just to the west of the Clarence, and almost adjoining it; five miles north-west of Leonora.

The deposit, which is of similar character, was discovered in 1897 by Messrs. Ferry and Pain, and has also a strike of 25 degrees east of north and a southerly dip of 65 degrees.

The prospectors sunk a shaft to a depth of about 65 feet, and stopped all the payable ore they could find above water level.

CLIFTON HILL.

Lease.	Total Ore.	Total Gold. *	Average Grade.
No. 689c	tons. 104	ozs. 76'62	ozs. 0'73

* To end of 1903.

The lease is situated half-a-mile east of the Clarence, five miles north-west of Leonora.

There are two quartz veins in the foliated greenstone with a strike of about 45 degrees and 10 degrees west of north respectively, and an average underlay to the east. They were discovered by a prospector named Vetter, and have been worked intermittently by shallow shafts along the outcrop.

PRIDE OF LEONORA.

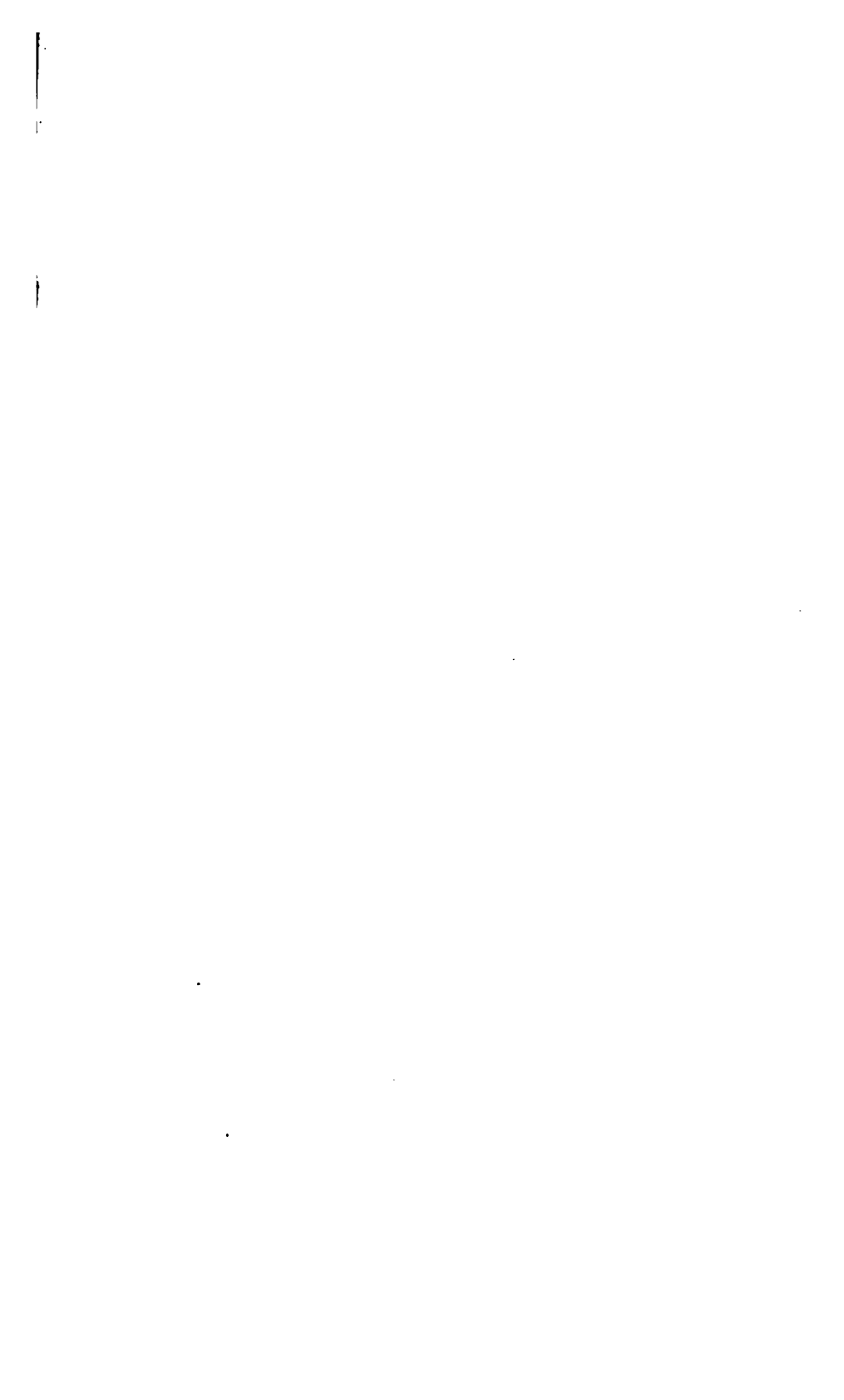
(Ironstone.)

Lease.	Total Ore.	Total Gold.	Average Grade.
No. 618c	tons. 1,213	ozs. 1,152'86	ozs. 0'95

* To end of 1903.



The "Ironstone" Mine, showing white kaolin and surfaces covered with clay ironstone.



The lease is situated four miles north-east of Leonora, and the original discoverers of gold at the spot in 1898 were Messrs. Goodall and Williams. The property is now locally owned and worked.

The deposit is in the granitic schists, and is the most important of those which have been classed as a fourth and separate series in the district; having many features of interest, but on the whole not as productive as others described.

The rock containing them—originally a micaceous schist as already stated—contained, as well as plagioclase feldspars which are so much more subject to kaolinisation than the potash varieties, an iron-bearing mineral in the form chiefly of white mica; and the anhydrous or lower-hydrated mica becoming hydrated, with at the same time an increase of bulk, has been a factor tending to a rapid weathering.

Decomposition has extended to a very great depth, and the rock become converted into a white kaolin-like clay. The process, moreover, taking place with an insufficient supply of oxygen, has further resulted in a solution of certain of the ferriferous salts; which in the joints and vein-fissures, and where a small supply of oxygen might be met with, have been re-deposited in the form of an insoluble sesquioxide, thus producing the characteristic brown coating of the quartz veins in the formation, and ultimately giving rise to the large quantities of ferruginous clay ironstone referred to already on the surface (Plate IX.).

The main vein on lease No. 618, with a strike of 23 degrees west of north, has an easterly dip of 50 degrees; and has with the accompanying ferruginous matter been stoped in many places for a considerable thickness.

The prospectors worked by shafts chiefly on the outcrop, but it is the present intention to intercept the vein by a vertical shaft, which has now been sunk to a depth of 180 feet; and in the material obtained from the bottom of this shaft, though some of the white mica is still showing white and intact, an original schistose structure is only just apparent.

This is the deepest sinking yet undertaken in the formation, hitherto only prospected above water level, and further developments will no doubt furnish many results important in connection with the value of the deposits generally.

About 10 chains to the west is a small vein which is being opened up on lease No. 850c., and this, though smaller and the quartz less ferruginous, is similar in most of its characteristics to that at the Pride of Leonora, the containing rock being similarly decomposed.

ASHLEY'S UNITED.

Lease.	Total Ore.	Total Gold.*	Average Grade.
No. 679c	tons. 343	ozs. 421'61	ozs. 1'23

* To end of 1903.

The lease is situated $4\frac{1}{2}$ miles east-north-east of Leonora, and was originally known as "Ashley's Find." The deposit was discovered shortly after the Forrest reef by some of the original prospectors.

The gold from Ashley's United has been obtained from two quartz reefs which have a strike in an east and west direction; the dip being at a fairly high angle to the north; and these veins are supposed, by prospectors working there at present, to be leaders from a main reef lying to the west. There is a highly ferruginous mass outcropping to the west, which contains quartz, and shows gold by dollying even in the ferruginous portion, but in that case it is generally a film on the parting surfaces.

The quartz veins vary from three inches to 18 inches in thickness; and with the surrounding iron oxide and clay ironstone, which also contains gold, have formed an ore body of much greater width, which has been stoped in places from water level to the surface—about 60 feet.

Just to the east of Ashley's United is a group of old leases which were, no doubt, taken up on account of the alluvial deposit, the "Specking Patch" already referred to (page 20). Several shafts were sunk, and I believe a little gold obtained from some small quartz veins with a north and south strike and an easterly dip.

In connection with the deposits in the granitic schists, a lease situated about $1\frac{1}{2}$ miles north-west of the Ironstone and outside the area of the map cannot be overlooked.

THE SONS OF AUSTRALIA.

Camel Leases.

Lease.	Total Ore.	Total Gold.*	Average Grade.
No. 914c (526c)	tons. 690'50	ozs. 963'72	ozs. 1'41

* To end of 1903.

The prospectors most identified with the Sons of Australia were Hurkett and party, who sank several shafts, one at least to a depth of more than 100 feet. The deposit is in a similar formation to that at the Pride of Leonora and Ashley's United.

LEASES OF MINOR IMPORTANCE.

Voided Leases and Sundry Claims.

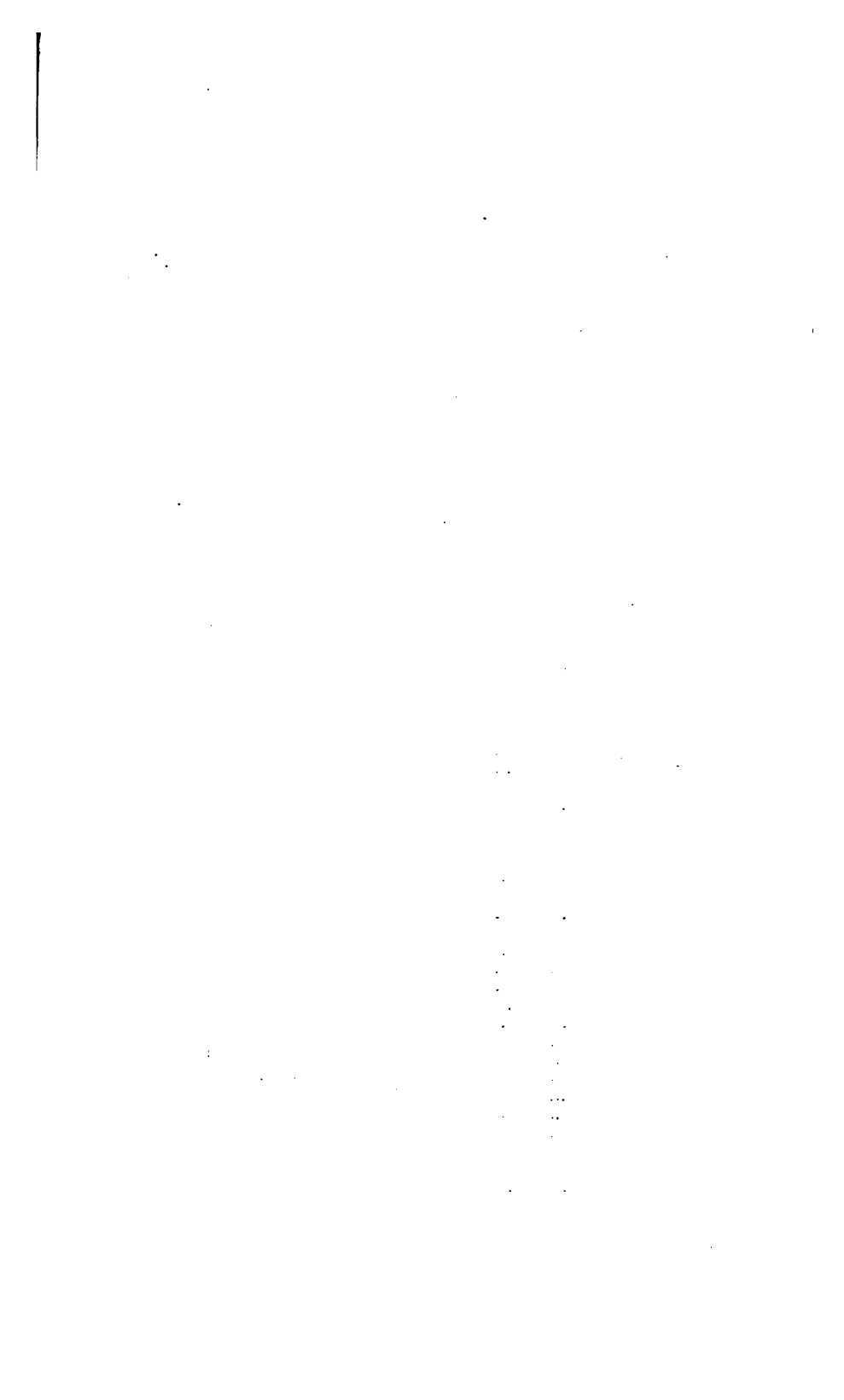
In addition to those referred to in detail, there are a great number of other leases which have no geological importance, in that they present no structural features of especial note, and which, in fact, have only an interest in so far as they have added a small increment to the total production of the district. The particulars of each are tabulated hereunder.

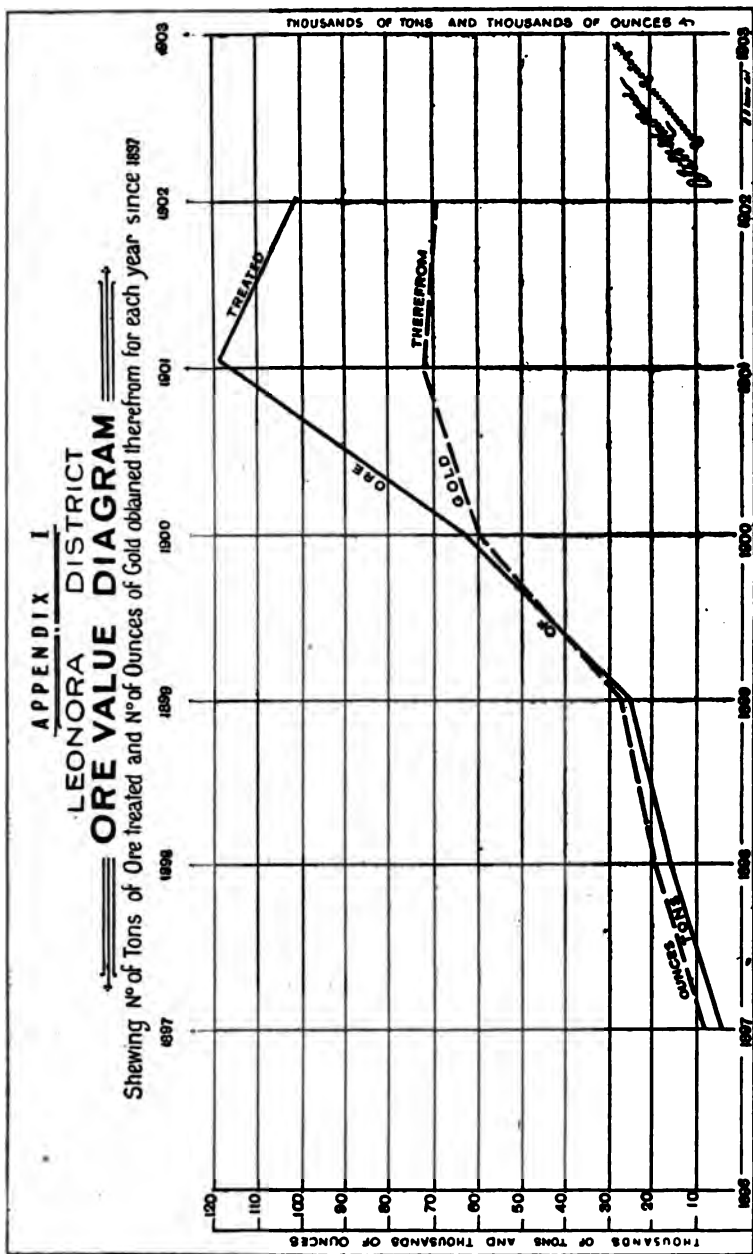
The total production of all leases in the Leonora district has already been stated in the opening paragraphs of that portion of the report referring specially thereto.

PRODUCTION OF LEASES OF MINOR IMPORTANCE.

	Lease No.	Total Gold. a	Average Grade.
		ozs.	ozs.
All Nations	886c	33.50	0.56
British Legation	795c	7.75	1.10
Clean Sweep	820c	17.55	5.85
Comet	522c	66.54	1.41
Croydon	585c	51.28	0.28
Easter Gift	769c	2.65	0.18
Fitzgerald's Amalgamated	708c	9.15	0.18
Flanders	562c	10.40	0.44
Grey Lode	704c	19.09	0.29
Gwalia Gem	558c	42.26	0.52
Kruger Steyn	796c	85.75 b	...
Lady Lena	503c	37.40	1.55
Lady Lena North	520c	44.08	1.27
Lady Muriel	984c	59.30	0.23
Last Chance	990c	6.57	0.15
Little Dorothy	992c	43.91	1.16
Mt. George Battery	92/5c	2,175.43 c	0.82
New Year's Surprise	828c	93.25 d	3.29
North Riviera	818c	6.00	0.60
Ottawa	771c	14.75	0.52
Otterburn	354c	2.18	0.86
Pride of Leonora North	649c	6.45	0.35
Royal Flush	931c	116.64 e	3.18
Riviera	802c	157.29 f	1.17
Rajah	455c	36.95	1.98
Reliance	589c	97.33	0.53
St. Heliers	952c	16.95	0.80
Scallywag	577c	8.00	0.50
Sheffield	725c	37.85	2.32
Supreme	772c	5.05	0.42
Turn of Tide	625c	3.89	0.35
Victor	835c	307.48 g	1.27
Warragamba	1008c	36.95	0.53
Westralian Broken Hill	1006c	8.02	0.22
Wyangle	627c	4.56	0.36
Sundry Claims	...	1,484.44	...

a To end of 1903. b Includes 11ozs. from specimens. c Includes 25ozs. from specimens. d Includes 1oz. from specimens. e Includes 78.44ozs. from specimens. f Includes 115.19ozs. from specimens. g Includes 225.34ozs. from specimens.





APPENDIX II.

DESCRIPTIVE REGISTER OF SPECIMENS FROM THE LEONORA DISTRICT.

Register Number.	Slice Number.	Rock.		Variety.	Obtained from—	Locality.
		Field Type.				
5217	430	Greenstone	Massive	...	Outcrop	500 yards S.S.W. of Mount George
5088	406	Greenstone	Massive	...	Outcrop	Tower Hill Lease No. 4387
5089	413	Greenstone	Massive	...	Outcrop (weathered)	½ mile north of Pride of Leonora Mine
5220	424	Greenstone	Crushed	...	Outcrop	½ mile S.S.W. of Mount George
5221	425	Greenstone	Crushed	...	Outcrop	500 yards S.W. of Mount George
5092	407	Greenstone	Foliated	...	Mine	Sons of Gwalia, East Crosscut
5093	408	Greenstone	Foliated	...	Mine	do do
5218	421	Greenstone	Foliated	...	Mine	do do
5215	419	Greenstone	Foliated	...	Mine	do do
5105	418	Greenstone	Foliated	...	Mine	do do
5090	...	Greenstone	Schistose	...	Outcrop (weathered)	Tower Hill Lease No. 4388
5087	404	Greenstone	Schistose (chlorite)	...	Outcrop	do do No. 4390
5089	...	Greenstone	Schistose (talc)	...	Mine	do do No. 4387
5091	...	Greenstone	Altered	...	Outcrop (weathered)	do do No. 4388
5218	422	Greenstone	Altered	...	Outcrop	½ mile east of Mount George
5219	423	Greenstone	Altered	...	Outcrop	do do do
5104	...	Greenstone	Altered	...	Outcrop	do do do
5226	...	Greenstone	Altered	...	Outcrop (weathered)	do do do
5093	...	Greenstone	Altered	...	Outcrop (weathered)	do do do
5096	412	Greenstone	Diabase	...	Outcrop	Near junction of telegraph lines, N.E. of Leonora
5082	401	Granite	Crushed	...	Outcrop	Near Trig. Station, Mt. Leonora
5083	402	Granite	Crushed	...	Outcrop	do do do
5084	...	Granite	Crushed	...	Outcrop	do do do
5085	403	Granite	Crushed	...	Outcrop	do do do
5100	414	Granite	Crushed	...	Outcrop	do do do

5064	408	Granite	...	Crushed	...	Outcrop	...	N.E. side of Lawlers Road, near Trump Mine
5224	428	Granite	...	Crushed	...	Outcrop	...	South of Leonora Main Reefs Lease 253c
5225	429	Granite	...	Crushed	...	Mine...	...	Leonora Main Reefs Lease No. 210c
5097	411	Porphyry	...	Crushed	...	Outcrop	...	East of Mt. George telegraph line 74½ miles
5098	410	Porphyry	...	Crushed	...	Outcrop	...	400 yards west of Pride of Leonora Mine
5096	...	Granite	...	Schistose	...	Outcrop (weathered)	...	Near road from township to Pride of Leonora
5370	...	Granite	...	Schistose	...	Outcrop	...	East of Sons of Gwalia Lease 525c
5227	...	Micas Schist	...	...	...	Shaft	...	Lease No. 537c
5231	...	Schist	...	With Granular Graphite	...	Shaft	...	Lease No. 587c
5373	...	Earthy Travertine	...	"Cement"	...	Surface	...	Tower Hill Lease No. 4390
5371	...	Siliceous Limestone	...	...	...	Trench	...	East margin Lake Recesside, west of Gwalia
5296	431	Siliceous Rock	...	Re-cemented	...	Outcrop	...	West margin Lake Recesside, west of Gwalia
5101	415	Quartz	...	Banded	...	Outcrop	...	Lease No. 523c
5102	416	Quartz	...	Banded	...	Outcrop	...	Lease No. 523c
5222	426	Quartz	...	Banded	...	Outcrop	...	Trig. Station, Mt. George
5372	...	Quartz	...	Banded	...	Outcrop	...	Lease No. 786c (Savanah)
5103	...	Quartz	...	With Ferriferous Dolomite	...	Outcrop	...	Tower Hill Lease No. 4388
5223	...	Ore	...	Typical Specimen	...	Mine...	...	Tower Hill Lease No. 4390
5229	...	Ore	...	With Acticular Tourmaline	...	Mine...	...	Sons of Gwalia
5369	...	Ore	...	Typical Specimen	...	Mine...	...	Do do
5330	...	Ore	...	With Asbolite	...	Mine...	...	Leonora Main Reefs
5232	...	Ore	...	Typical Specimen	...	Mine...	...	Trump Lease No. 263

C. F. V. JACKSON,
Assistant Government Geologist.

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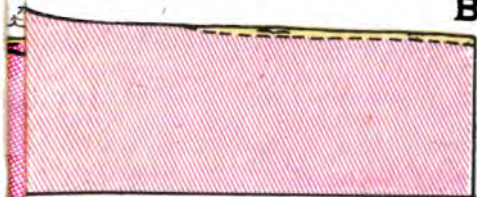
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WILORA TYPE

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